NPOESS

Entering a New Era

National Polar-orbiting Operational Environmental Satellite System

Delivering Global Data

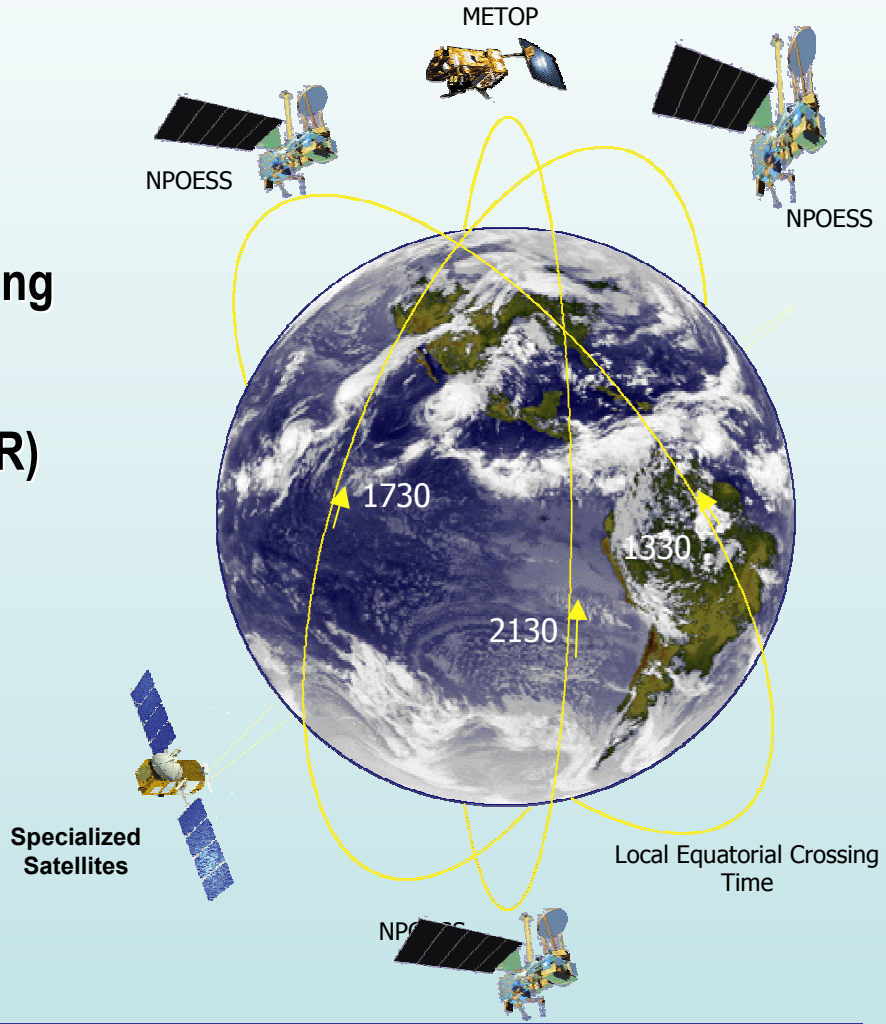
Direct Readout Conference of the Americas

John D. Cunningham
System Program Director
December 6, 2004

Tri-agency Effort to Leverage and Combine Environmental Satellite Activities

Mission

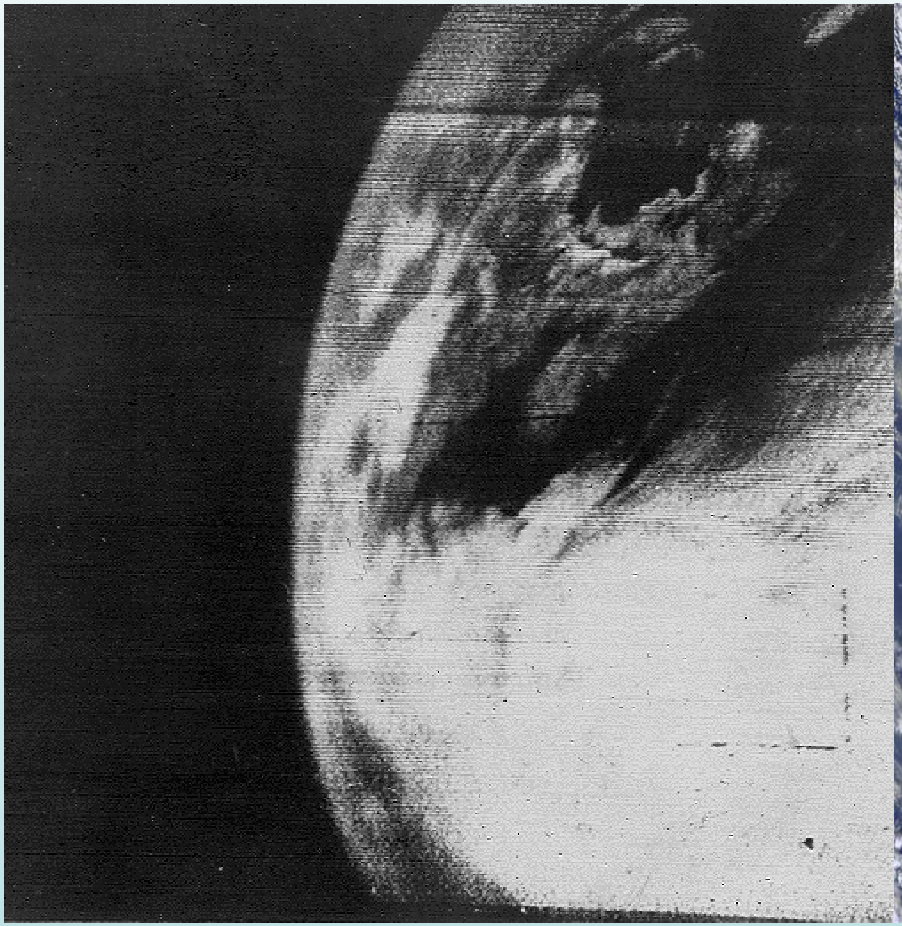
- Provide a national, operational, polar-orbiting remote-sensing capability
- Achieve National Performance Review (NPR) savings by converging DoD and NOAA satellite programs
- Incorporate new technologies from NASA
- Encourage International Cooperation



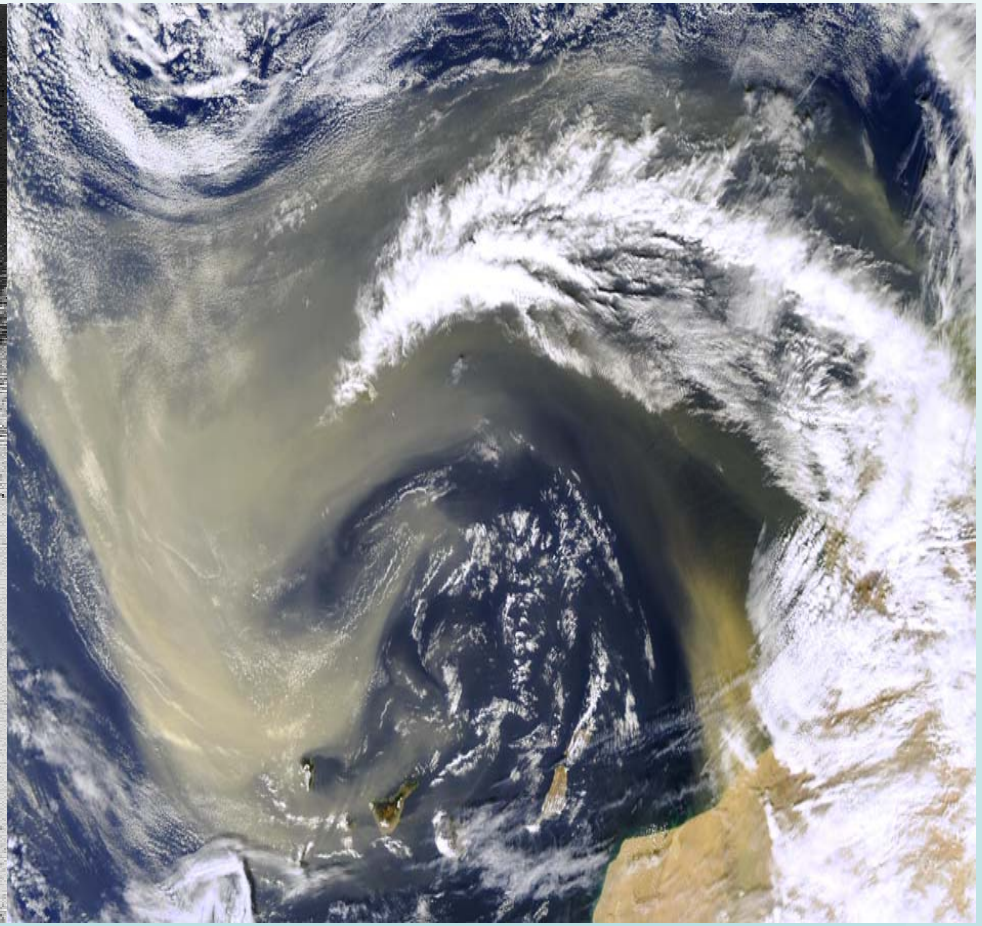
Saves as much as $1.3B from the cost of previously planned separate developments

Building A More Capable System
The Historical Context

First Image from TIROS-1



EOS-Aqua MODIS Image-250 m



Saharan Dust off the Canary Islands
18 February 2004

NPOESS Requirements

Convergence of Alternatives

Integrated Operational Requirements Document (IORD-I)

- 59 Data Products
- 9 Enhancement Products
- 1 System Characteristic KPP

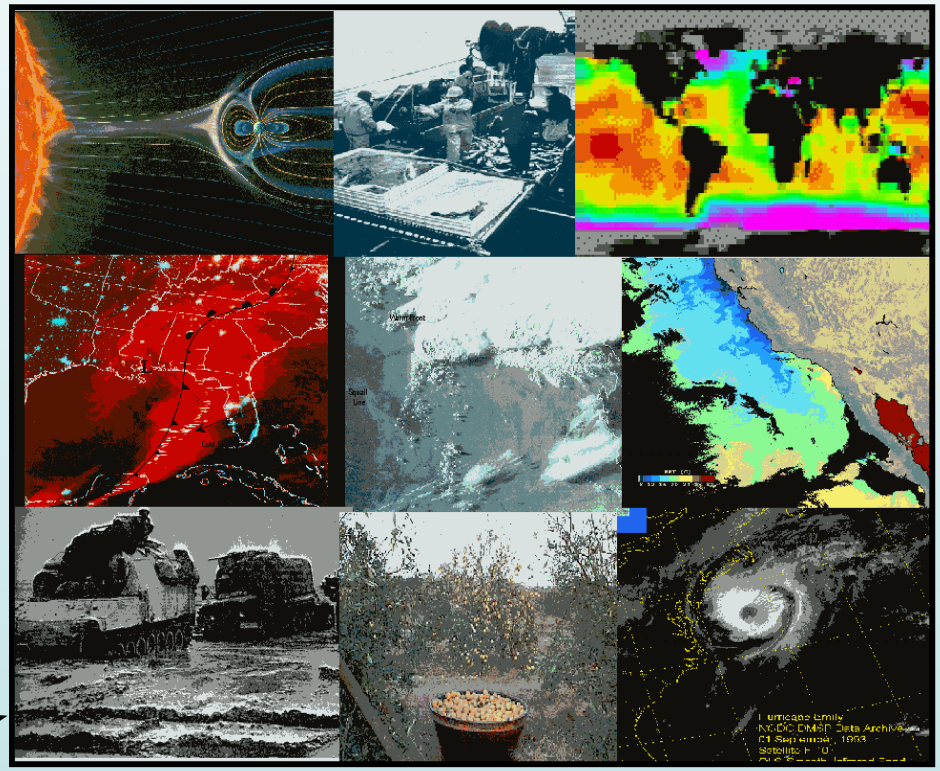
Validated by JARC 1996

IORD-II

- 55 Data Products
- 21 Enhancement Products
- 2 System Characteristic KPPs

Validated by JARC Dec 2001

Convergence of Requirements



Converged Requirements Provide Foundation for Combined Program

Integrated Operational Requirements Document (IORD) Example

Atmospheric Vertical Temperature Profile

Highly accurate measurement of the vertical distribution of temperature in the atmosphere in layers from the surface to 0.01 mb

Systems Capabilities	Thresholds	Objectives
a. Horizontal Cell Size		
1. Clear, nadir	18.5 km	1 km
2. Clear, worst case	100 km	1 km
3. Cloudy, nadir	40 km	1 km
4. Cloudy, worst case	50 km	1 km
b. Vertical Reporting Interval		
1. Surface to 850 mb	20 mb	10 mb
2. 850 to 300 mb	50 mb	10 mb
3. 300 to 100 mb	25 mb	10 mb
4. 100 to 10 mb	20 mb	10 mb
5. 10 to 1 mb	2 mb	1 mb
6. 1 to 0.1 mb	0.2 mb	0.1 mb
7. 0.1 to 0.01 mb	0.02 mb	.01 mb
c. Mapping Accuracy	5 km	0.5 km
d. Measurement Uncertainty (expressed as error in layer average temperature)**		0.5 K
Clear:		
1. Surface to 300 mb*	**1.6 K per 1 km layer**	
2. 300 mb to 30 mb	1.5 K per 3 km layer	
3. 30 mb to 1 mb	1.5 K per 5 km layer	
4. 1 mb to 0.01 mb	3.5 K per 5 km layer	
Cloudy:		
5. Surface to 700 mb*	**2.5 K per 1 km layer**	
6. 700 mb to 300 mb	1.5 K per 1 km layer	
7. 300 mb to 30 mb	1.5 K per 3 km layer	
8. 30 mb to 1 mb	1.5 K per 5 km layer	
9. 1 mb to 0.01 mb	3.5 K per 5 km layer	
e. Latency	156 minutes	15 minutes
f. Refresh	6 hours	3 hours
g. Long-Term Stability***		
1. Trop. Mean	0.05 K	0.03 K
2. Strat. Mean	0.10 K	0.05 K

Major Applications

1) Initialization of Numerical Weather Prediction Models

2) Complementary data for derivation of moisture/pressure profiles and cloud properties

Iterative, Disciplined Requirements Process Ensures Users Needs are Met

NPOESS EDR-to-Sensor Mapping

	VIIRS (24)	CMIS (19)	CrIS/ATMS (3)	OMPS (1)	SESS (13) (11)	ERBS (5)	TSIS (1)	ALT (3)	APS (4)
★ Atm Vert Moist Profile		●	●						
★ Atm Vert Temp Profile		●	●						
★ Imagery	●	●							
★ Sea Surface Temperature	●	●							
★ Sea Surface Winds		●							
★ Soil Moisture		●							
Aerosol Optical Thickness	●	●							
Aerosol Particle Size	●	●							
Aerosol Refractive Index	●	●							
Albedo (Surface)	●	●							
Auroral Boundary					●				
Auroral Energy Deposition					●				
Auroral Imagery					●				
Cloud Base Height	●	●							
Cloud Cover/Layers	●	●							
Cloud Effective Part Size	●	●							
Cloud Ice Water Path	●	●							
Cloud Liquid Water	●	●							
Cloud Optical Thickness	●	●							
Cloud Particle Size/Distrib	●	●							
Cloud Top Height	●	●							
Cloud Top Pressure	●	●							
Cloud Top Temperature	●	●							
Down LW Radiance (Sfc)					●				
Down SW Radiance (Sfc)					●				
Electric Fields					●				
Electron Density Profile					●				
Energetic Ions					●				
Geomagnetic Field					▨				
Ice Surface Temperature	●	●							
In-situ Plasma Fluctuation					●				
In-situ Plasma Temp					●				
Ionospheric Scintillation					▨				
Med Energy Chgd Parts					●				
Land Surface Temp	●	●							
Net Heat Flux	●	●							
Net Solar Radiation (TOA)						●			
Neutral Density Profile					●				
Ocean Color/Chlorophyll	●	●							
Ocean Wave Character								●	
Outgoing LW Rad (TOA)						●			
O_3 – Total Column Profile				●					
Precipitable Water	●	●							
Precipitation Type/Rate	●	●							
Pressure (Surface/Profile)	●	●							
Sea Ice Characterization	●	●							
Sea SFC Height/TOPO								●	
Snow Cover/Depth	●	●							
Solar Irradiance							●		
Supra-Therm-Aurora Prop					●				
Surface Type	●	●							
Active Fires (Application product)	●	●							
Surface Wind Stress						●			
Suspended Matter	●	●							
Total Water Content	●	●							
Vegetative Index	●	●							

LEGEND

★ - Key Performance Parameters

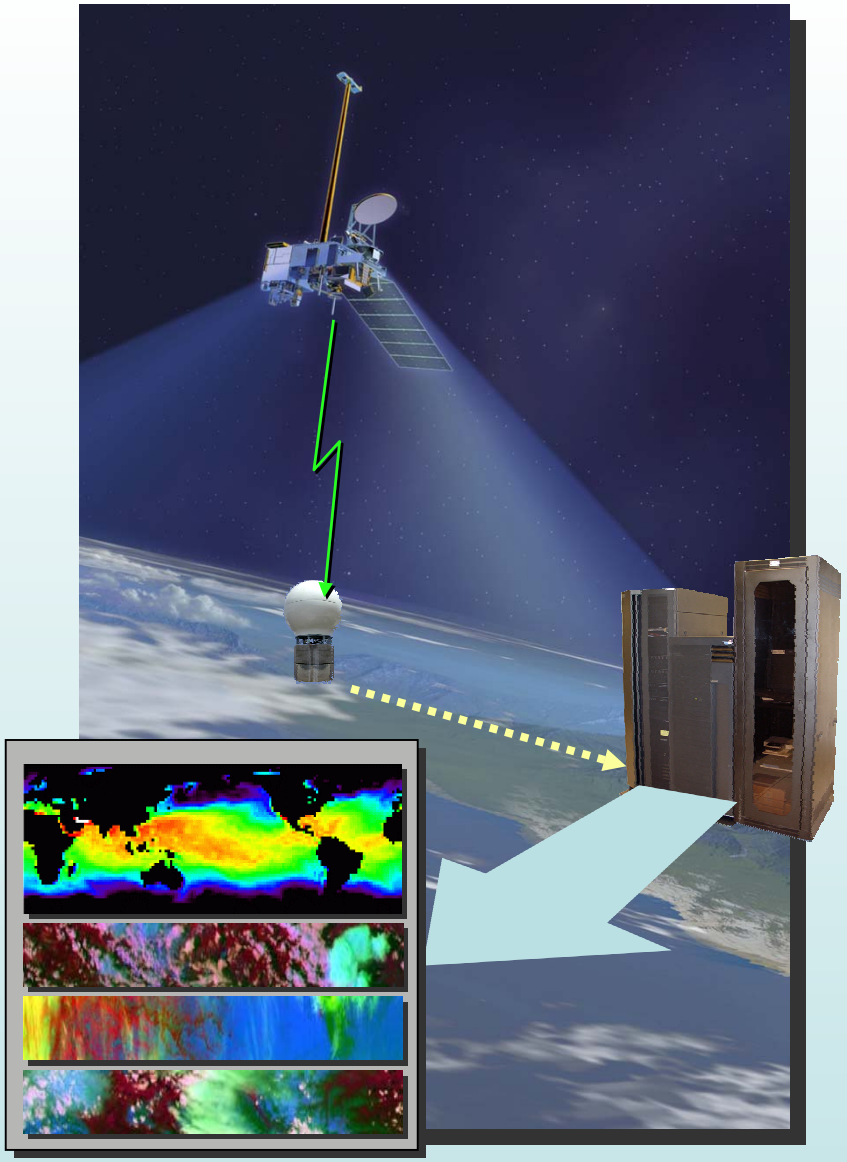
▨ To be moved to P³I when SESS change implemented

Pre-Planned Product Improvement (P3I) EDR Candidates

- Tropospheric winds
- Neutral winds
- All weather day/night imagery
- Coastal sea surface winds
- Ocean wave characteristics
- Surf conditions
- Oil spill location
- Littoral current
- CH4 column
- CO column
- CO2 column
- Optical background
- Sea and lake ice
- Coastal ocean color
- Bioluminescence potential
- Coastal sea surface temperature
- Sea surface height coastal
- Bathymetry
- Vertical hydrometeor profile
- Salinity

Program Schedule

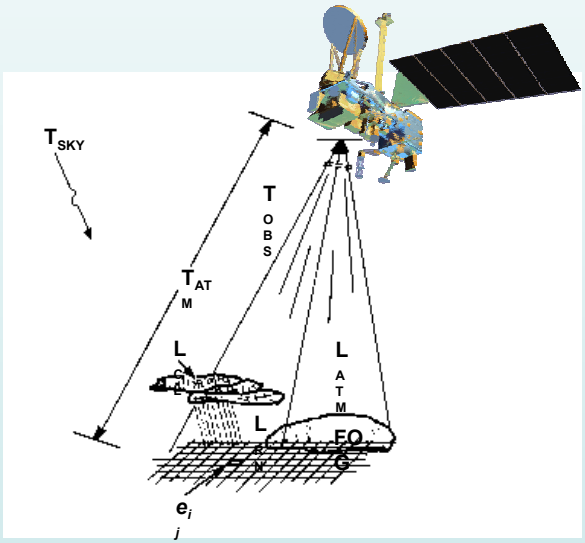
2002	A&O Contract Award
2003	NPP Delta Critical Design Review
2005	NPOESS ΔPreliminary Design Review
2006	NPOESS Critical Design Review NPP Ground Readiness
2006	NPP Launch
2009	NPOESS Ground Readiness
2009	NPOESS C1 Launch
2011	NPOESS C2 Launch Field Terminal Segment Readiness Initial Operational Capability
2013	NPOESS C3 Launch
2015	NPOESS C4 Launch
2017	NPOESS C5 Launch
2020	End of Program



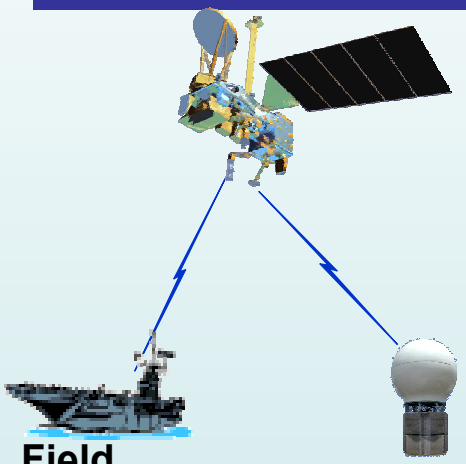
Reliable and timely collection, delivery, and processing of quality environmental data

NPOESS Operational Concept

1. Sense Phenomena



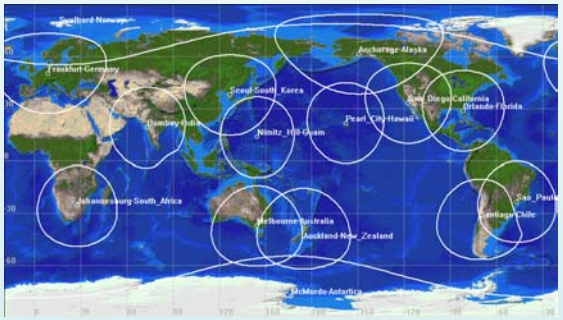
2. Downlink Raw Data



Field Terminals

SafetyNet™ Receptors

3. Transport Data to Centrals for Processing



Global fiber network connects 15 receptors to Centrals

Monitor and Control Satellites and Ground Elements

MMC (Suitland)

Schriever MMC

4. Process Raw data into EDRs and Deliver to Centrals

NESDIS/NCEP

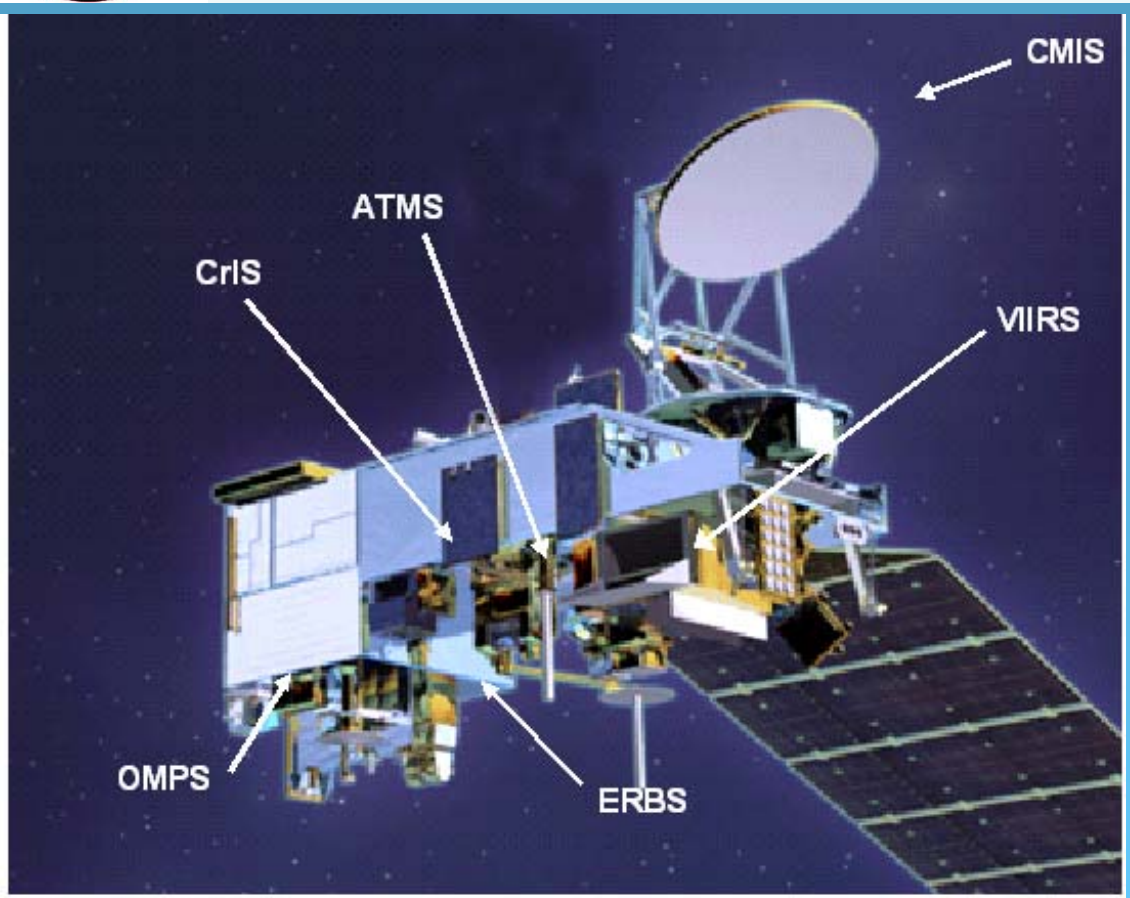
AFWA

FNMOC

NAVO

Full Capability at each Central

NPOESS Satellite and Sensors



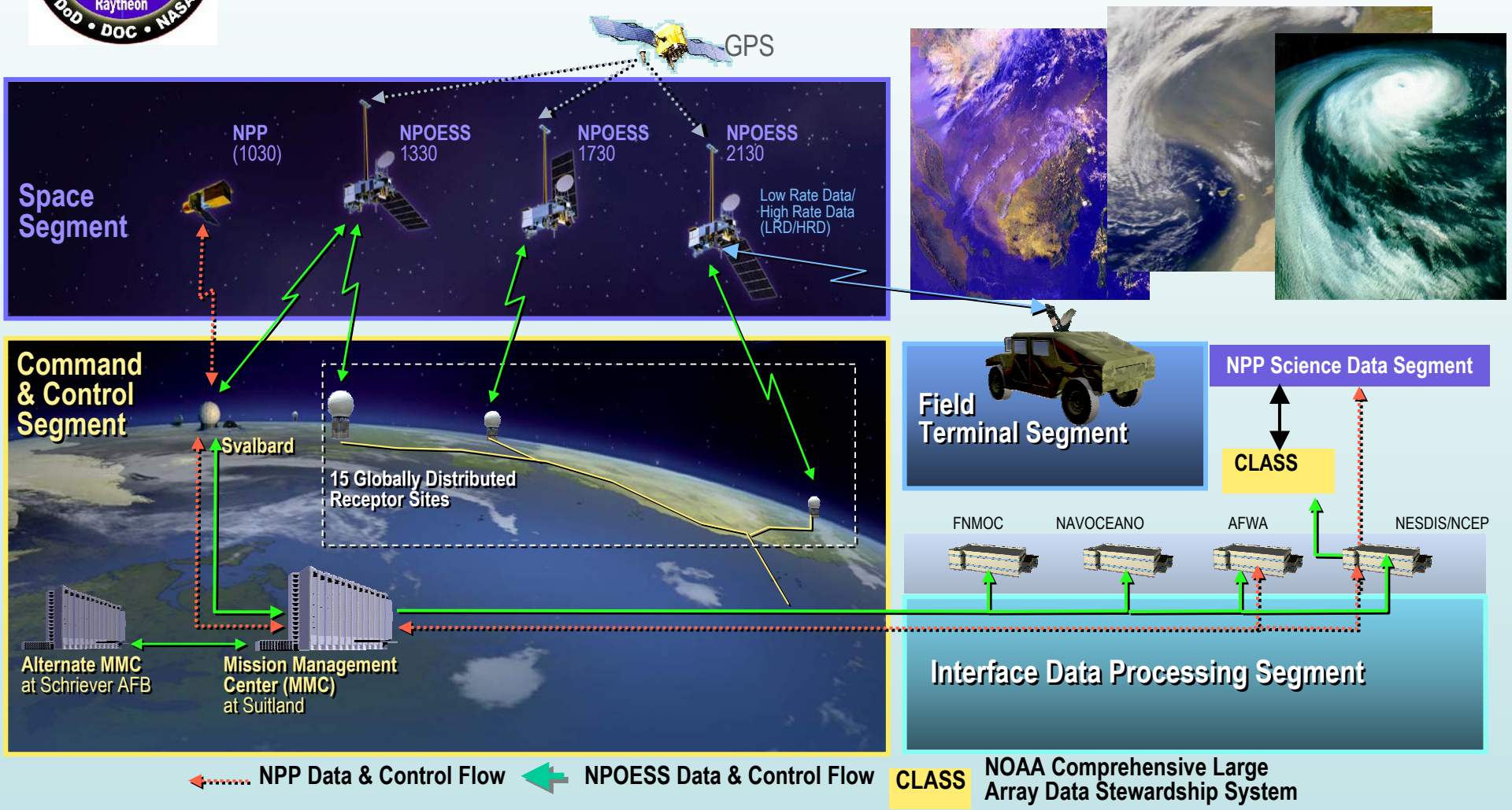
NPOESS 1330 Configuration

	1330	1730	2130	NPP
VIIRS	X	X	X	X
CMIS	X	X	X	
CrIS	X	X		X
ATMS	X	X		X
SESS	X	X	X	
OMPS	X			X
ADCS	X	X		
SARSAT	X	X	X	
ERBS	X			
SS	X	X	X	
ALT		X		
TSIS		X		
APS			X	

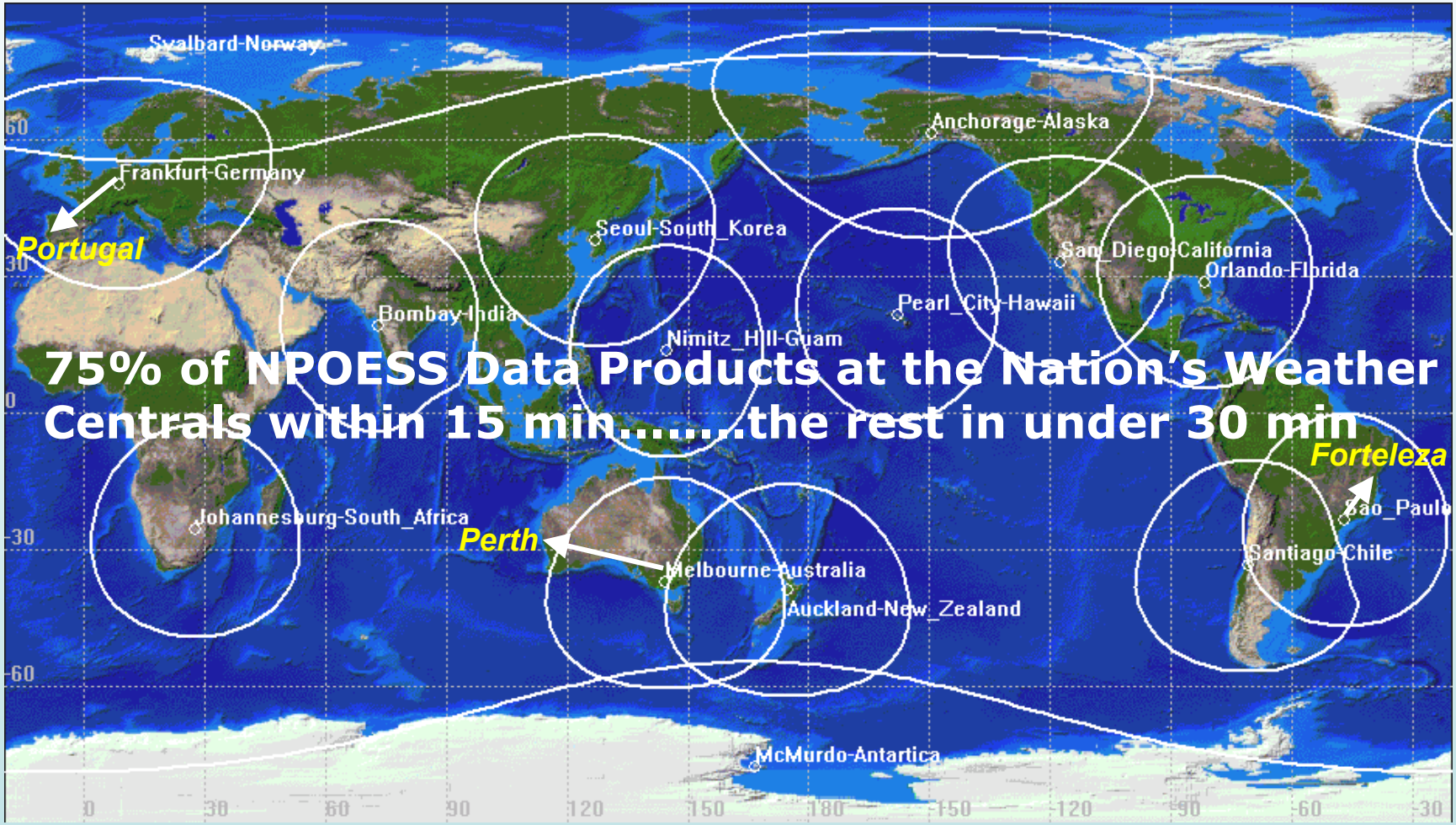
X = changed

Single Satellite Design with Common Sensor Locations and "ring" Data Bus Allows Rapid Reconfiguration and Easy Integration

NPOESS Top Level Architecture

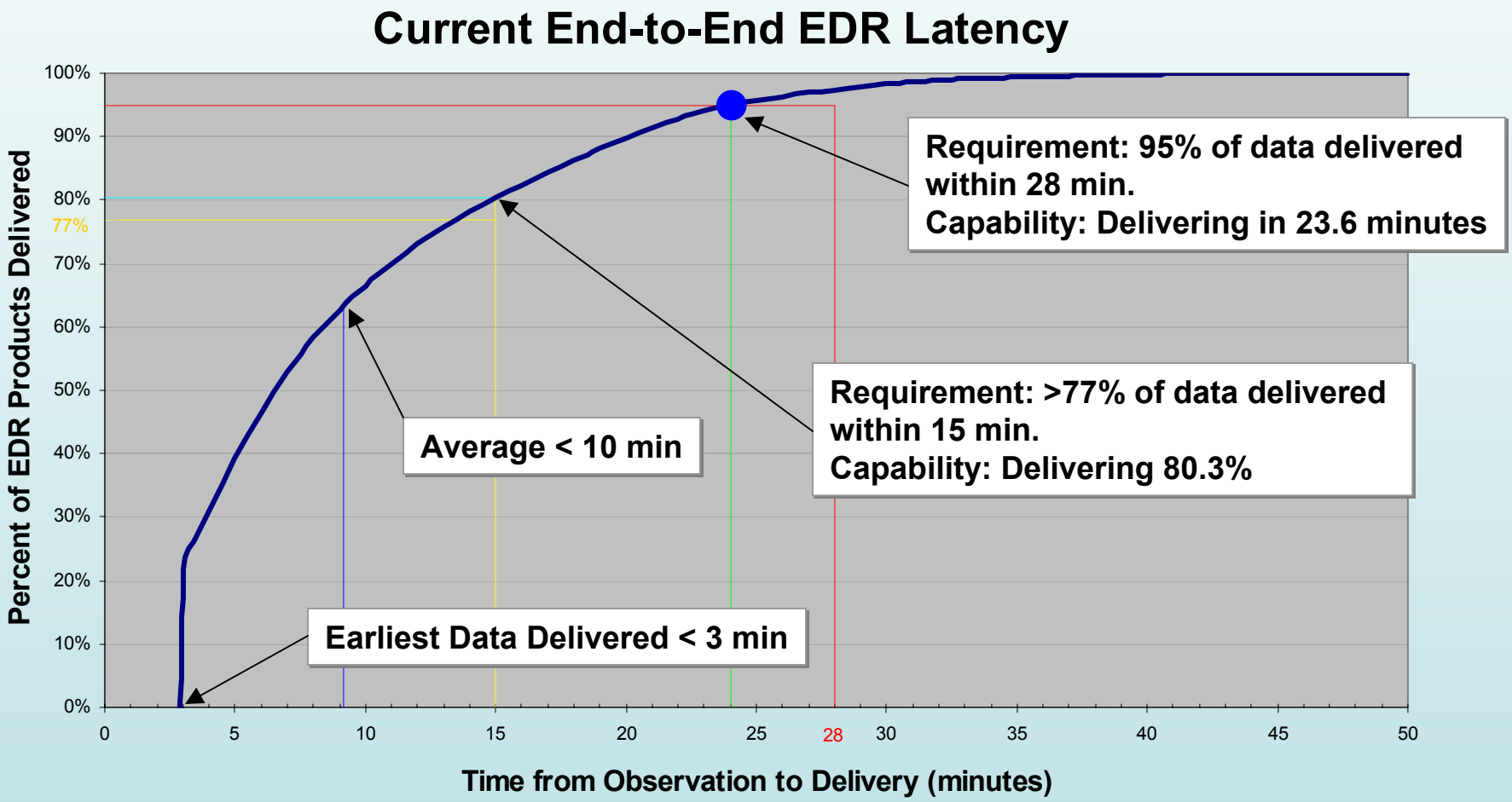


SafetyNet™ – The Key to Low Data Latency and High Data Availability



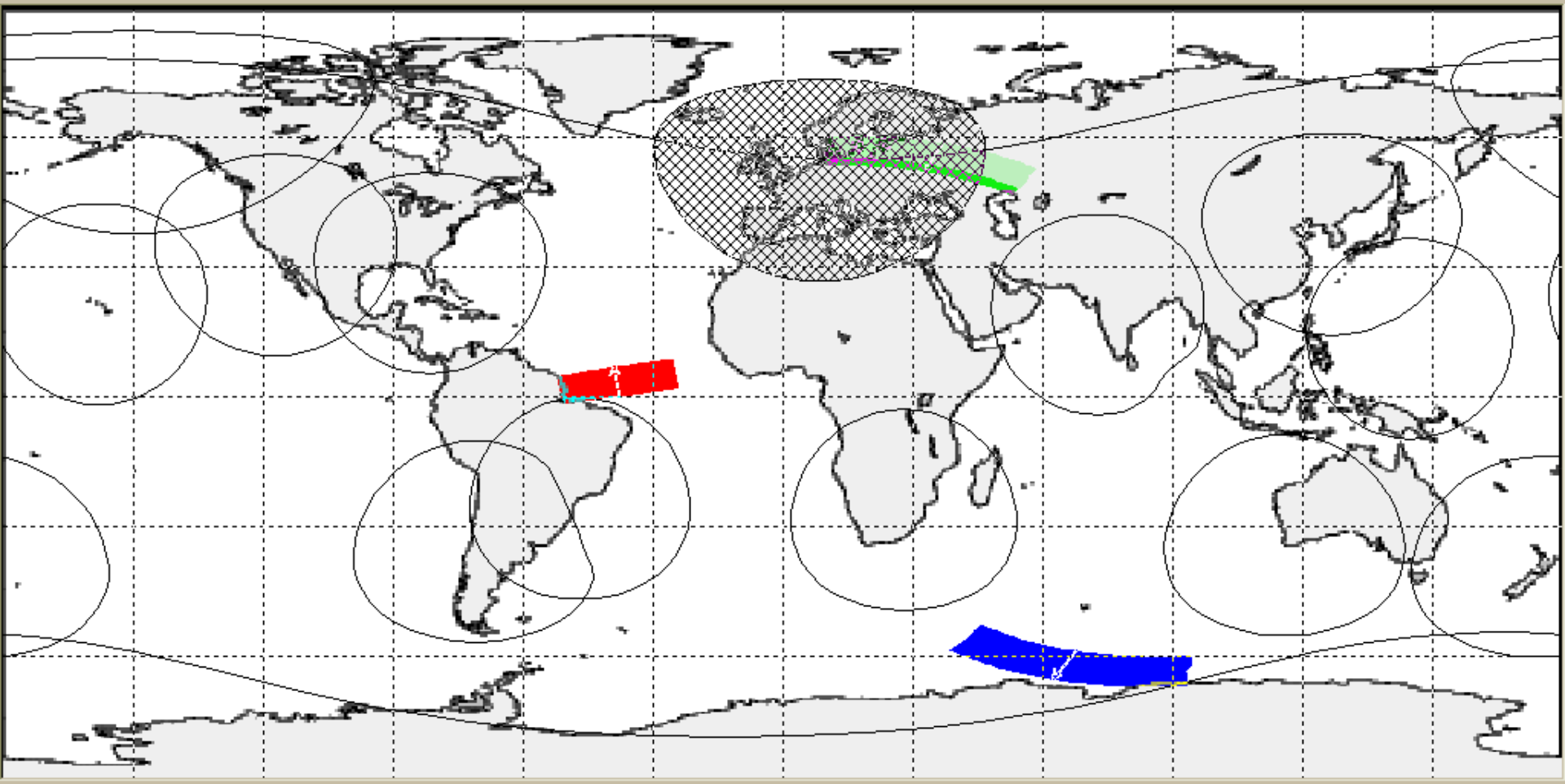
SafetyNet™ -- 15 globally distributed SMD receptors linked to the centrals via commercial fiber -- enables low data latency and high data availability

NPOESS EDR Processing Timeline

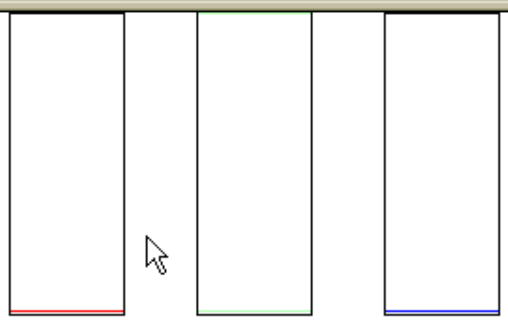


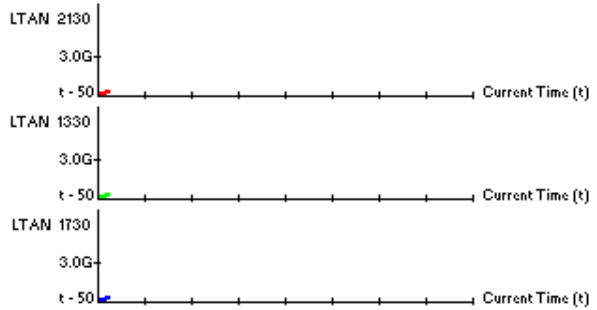
Untitled - fly

File Edit View Options Drawing Mode Geo Data Phase Run Help



Time Since Start:	00:00:02
Average Latency:	0.00
Median Latency:	0.0
95% Latency:	0.0
99% Latency:	0.0
Maximum Latency:	0.00
Conflict Time:	0.0
% Under 15 Minutes:	0%
Retran Avg Latency:	0.00
Retran Max Latency:	0.00
Runs:	2
	2

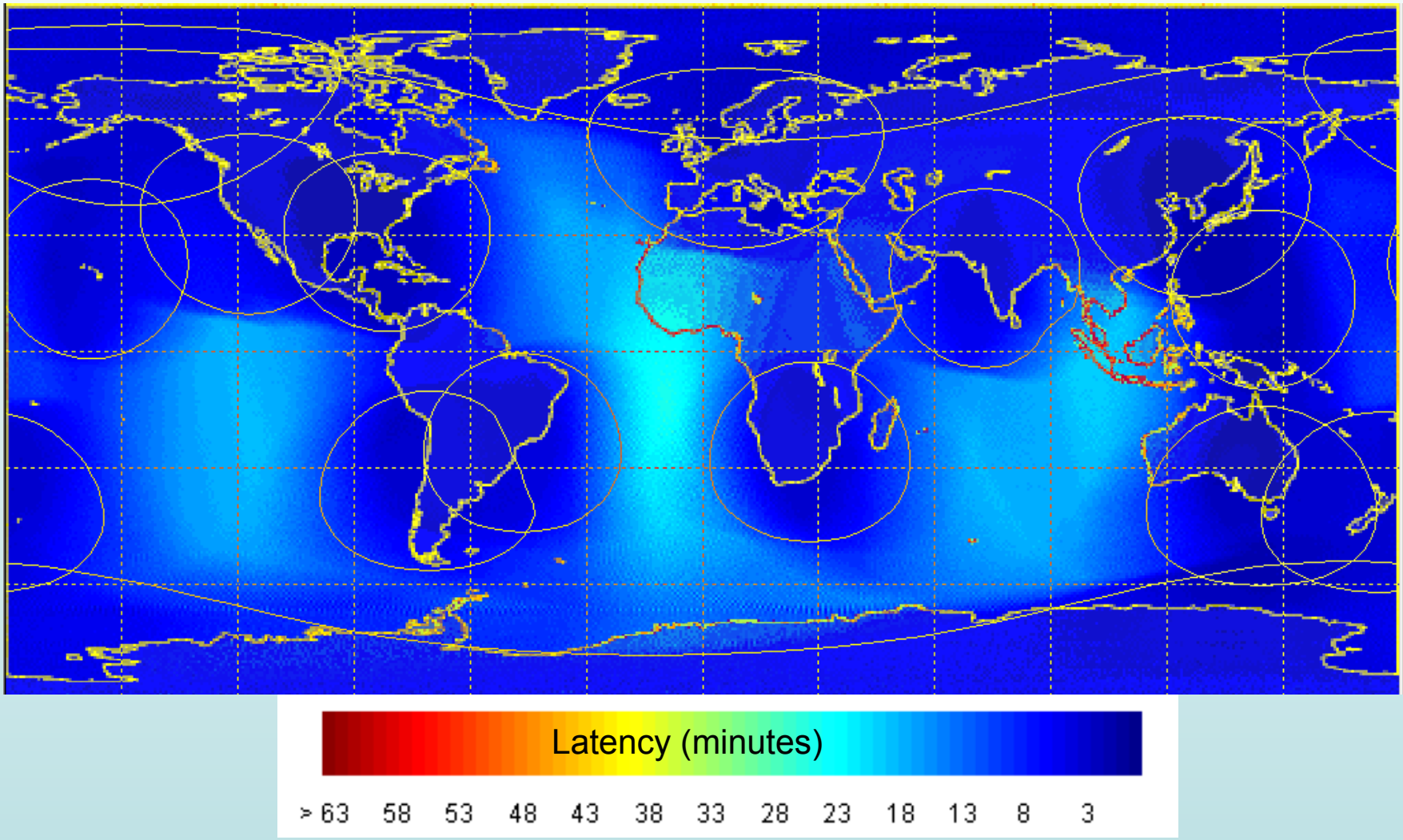




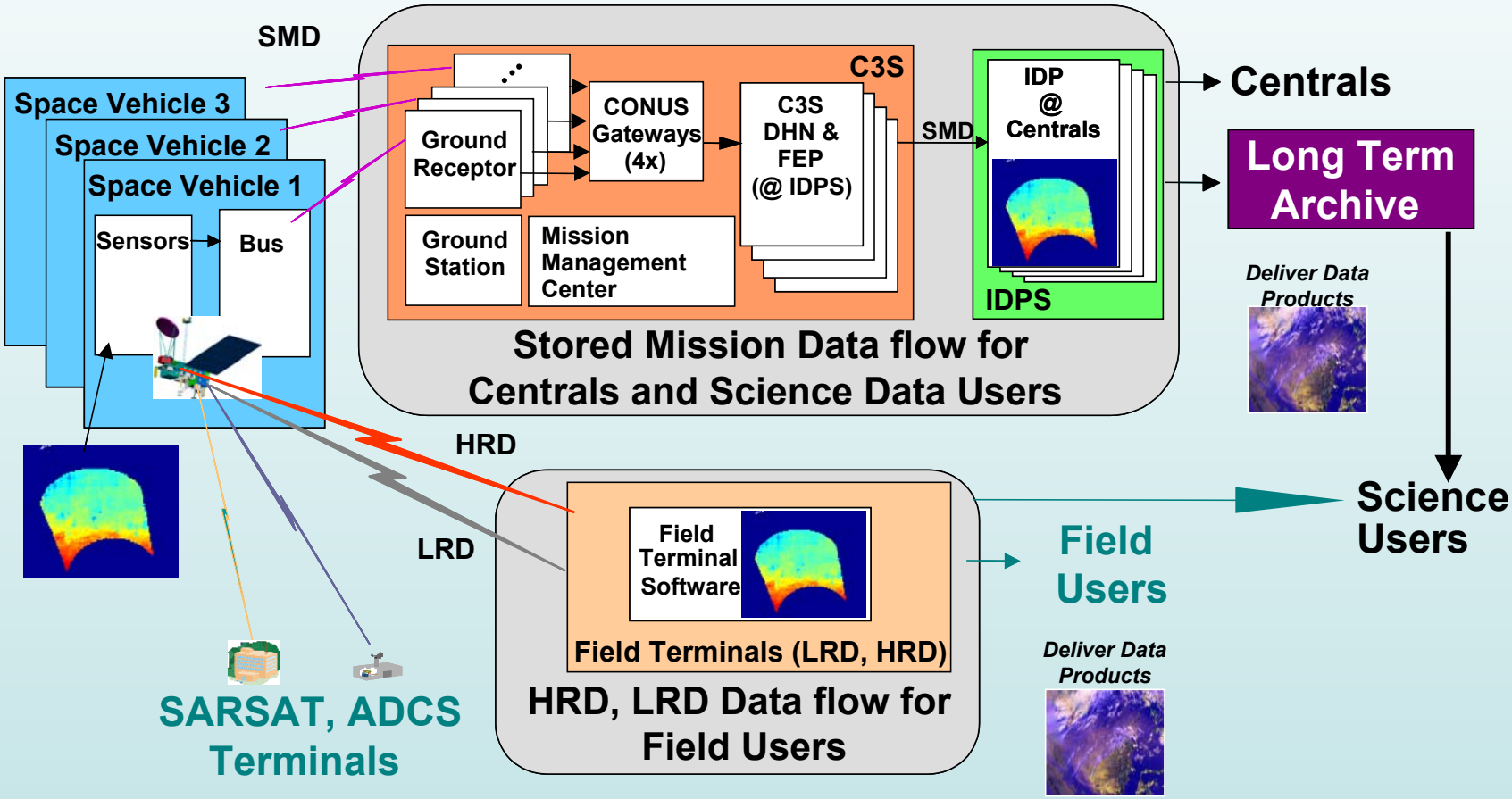
Ready

NUM

Average Data Latency



Mission Data Flow



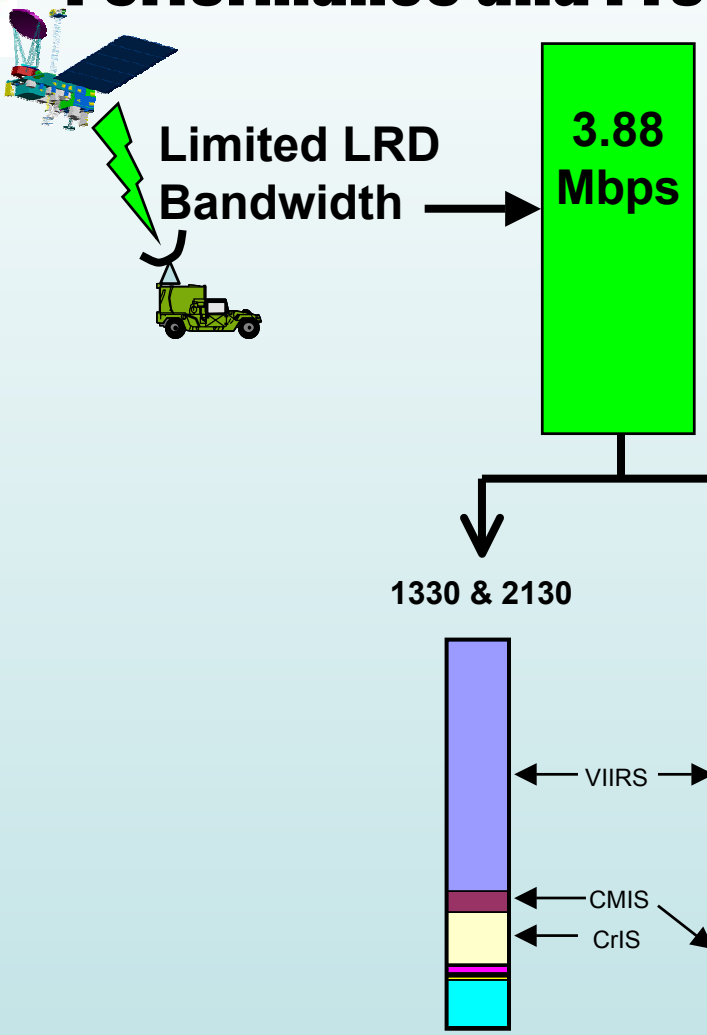
Timely, Accurate, Reliable Data from Sensors to Users

NPOESS Basics

There are three NPOESS data streams, potentially coming down simultaneously

- **SMD – stored mission data**
  - 100% of data observed by the satellite
  - All data stored on the onboard recorder since last 2 ground station contacts and real time data within station circle
  - 300Mbps at Ka band (very complex signal)
  - Set of 15 sites around the world are called "SafetyNet™'
    - » Linked to US by ATT fiber optic cable
- **HRD – high rate data**
  - 100% of NPOESS data as it is observed (real time) by the satellite in view of a readout station (except data from ERBS and TSIS)
  - Dynamic Ancillary data (3200 km swath)
  - 20 Mbps at X-band
- **LRD – low rate data**
  - Selected subset of NPOESS data
  - 6x1 Compression of VIIRS data
  - Dynamic Ancillary data (3200 km swath)
  - 3.8Mbps at L-band

NPOESS LRD Approach Balances Performance and Provides Flexibility



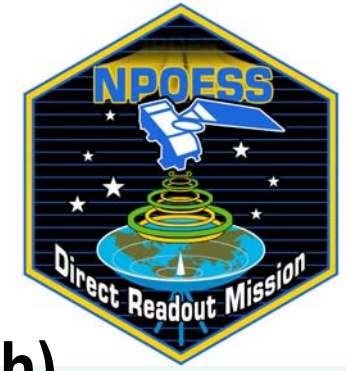
Selection of compression applied to selected APIDs for downlink for increased mission data throughput

Programmable LRD downlink provides flexibility for the future

NPOESS Direct Readout Data Plan

- **NPOESS contract requires NGST to:**
  - Define family of computers/systems to receive and process NPOESS data
    - Means solution is neither USA nor vendor specific
  - Provide software to process NPOESS HRD and LRD data
- **IPO plans to distribute both on web portal**
- **IPO and NASA Direct Readout Lab will provide other technologies to receive, process, and display data via web portal**

What Does An NPOESS Terminal Look Like?



- **Commercial 1-2 meter antenna with X, L (or both) feeds, appropriate RF and demodulation gear to convert from RF to digital signal**
- **Computer sized to:**
  - Amount of data user wants to process
  - Timeliness requirement user imposes on self
- **If existing site is modified, requires additional feed(s) for X, L band for antenna**
- **Estimated cost is <$100K**
- **Could also support GOES or other s/c at slightly additional cost**

Comprehensive Risk Reduction

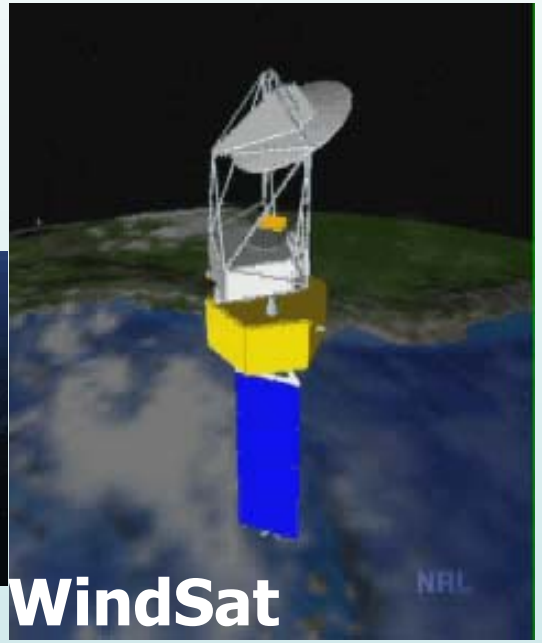
Validate technological approach to remote sensing

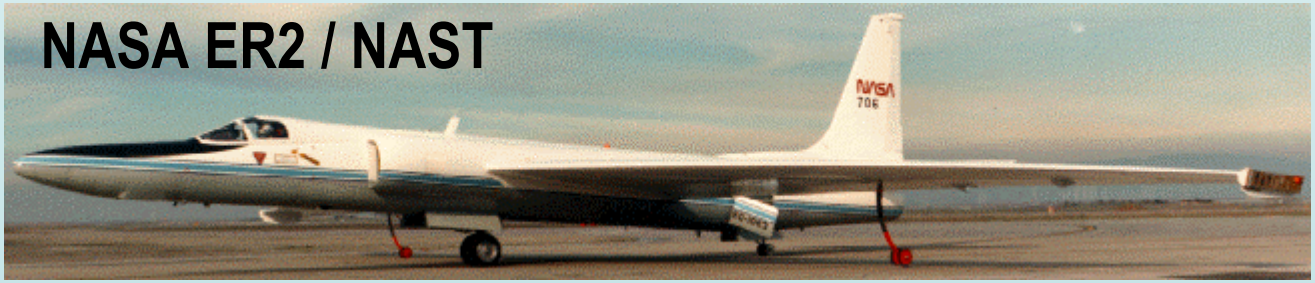
Early delivery of NPOESS data to users

Sensor demonstrations on non-operational platforms

- Lower risk to operational users
- Lower risk of launch delays due to operational schedule

Share cost & risk among agencies





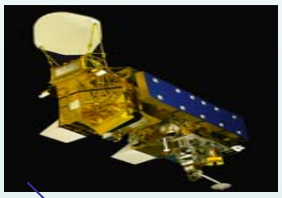
SOLSE

LORE

NPP
NPOESS PREPARATORY PROJECT

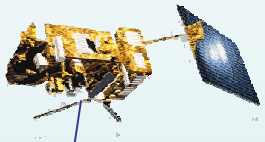
Real-Time Operational Demonstrations

Aqua (2002)
AIRS/AMSU/HSB & MODIS

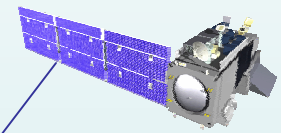


Coriolis
WindSat (2003)

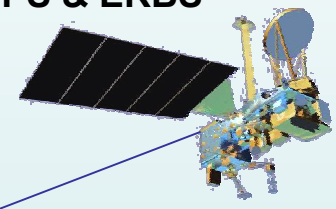
METOP (2006)
IASI/AMSU/MHS & AVHRR



NPP (2006)
CrIS/ATMS
VIIRS
OMPS



NPOESS (2009)
CrIS/ATMS, VIIRS, CMIS,
OMPS & ERBS



Use of Advanced Sounder Data for Improved Weather Forecasting/Numerical Weather Prediction

NOAA Real-Time Data Delivery Timeline Ground Station Scenario

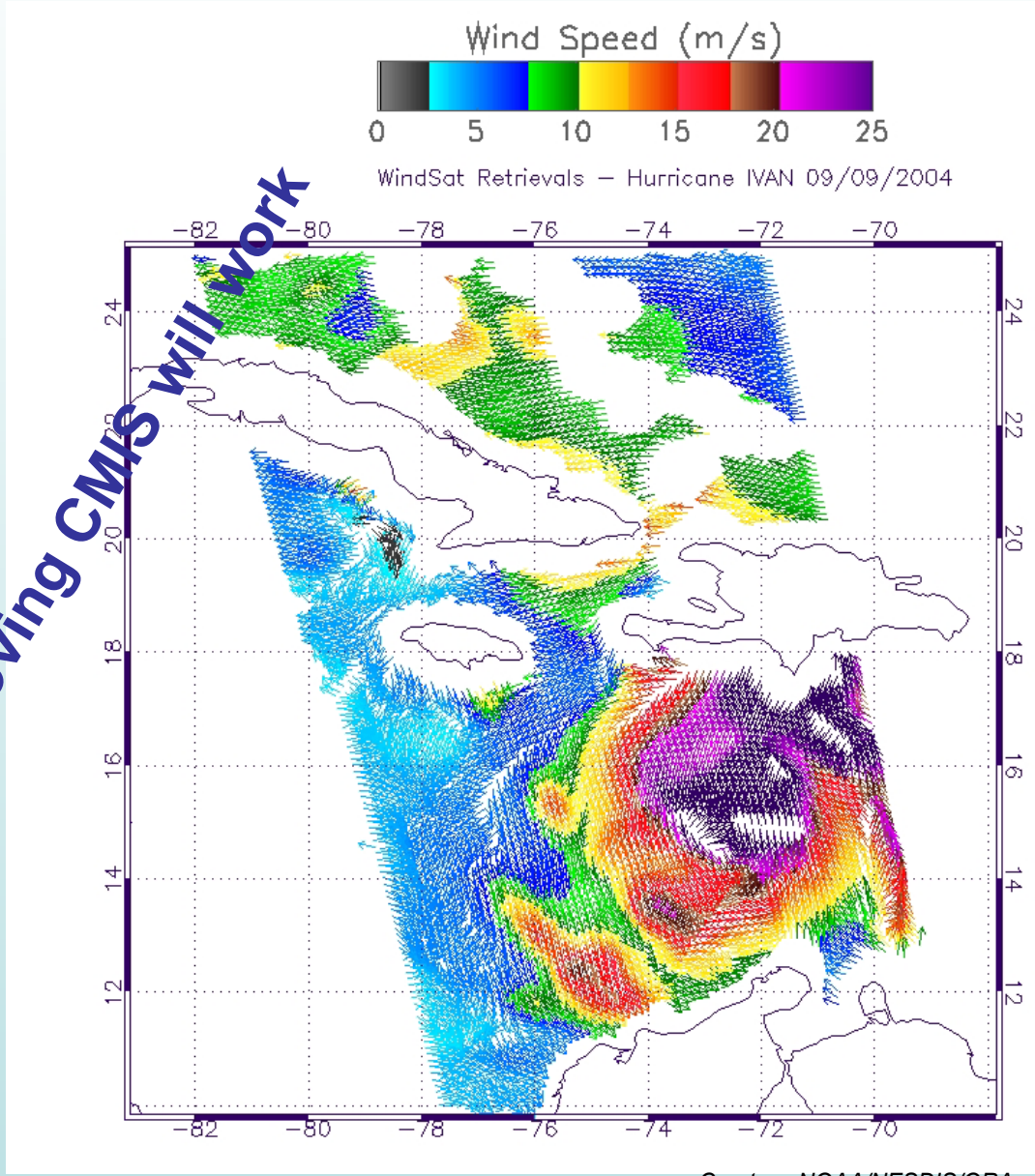
C3S → IDPS → NOAA Real-time User

Joint Center for Satellite Data Assimilation

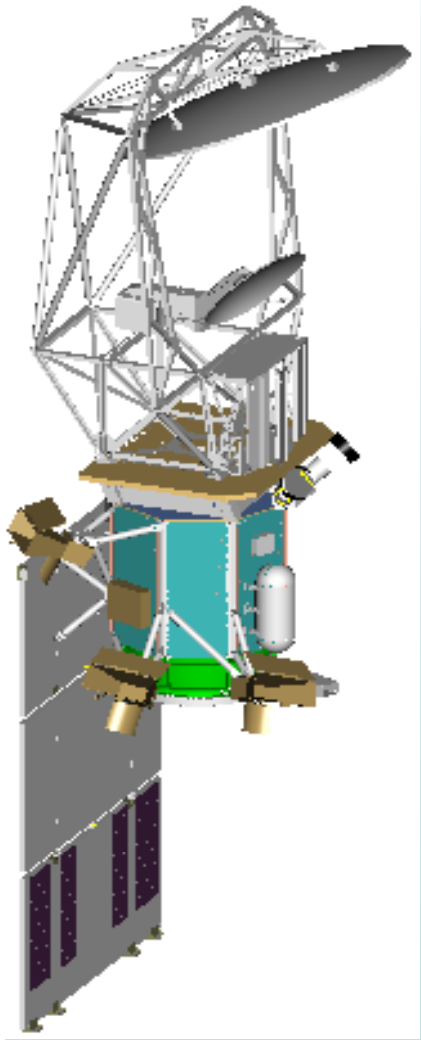
NWS/NCEP
GSFC/DAO
ECMWF
UKMO
FNMOC
Meteo-France
BMRC-Australia
Met Serv Canada

→ NWP Forecasts

WindSat Observes Hurricane Ivan



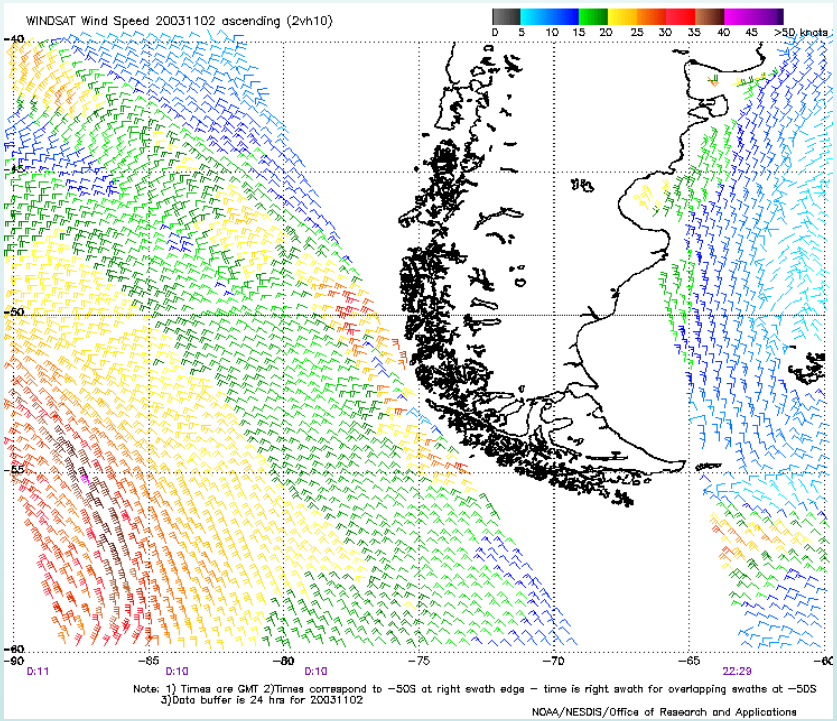
Coriolis is proving CMIS will work



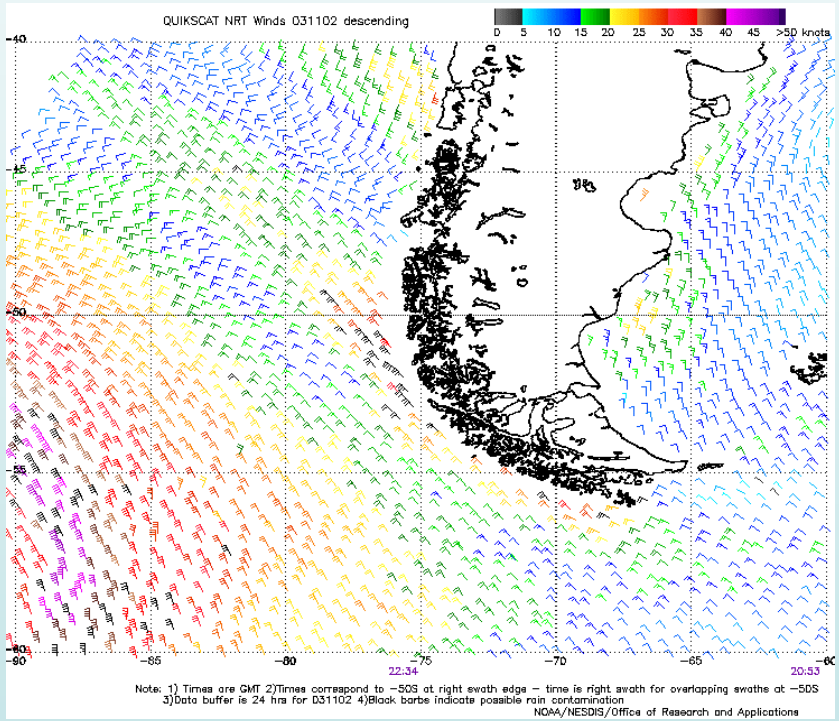
Courtesy NOAA/NESDIS/ORA and NRL

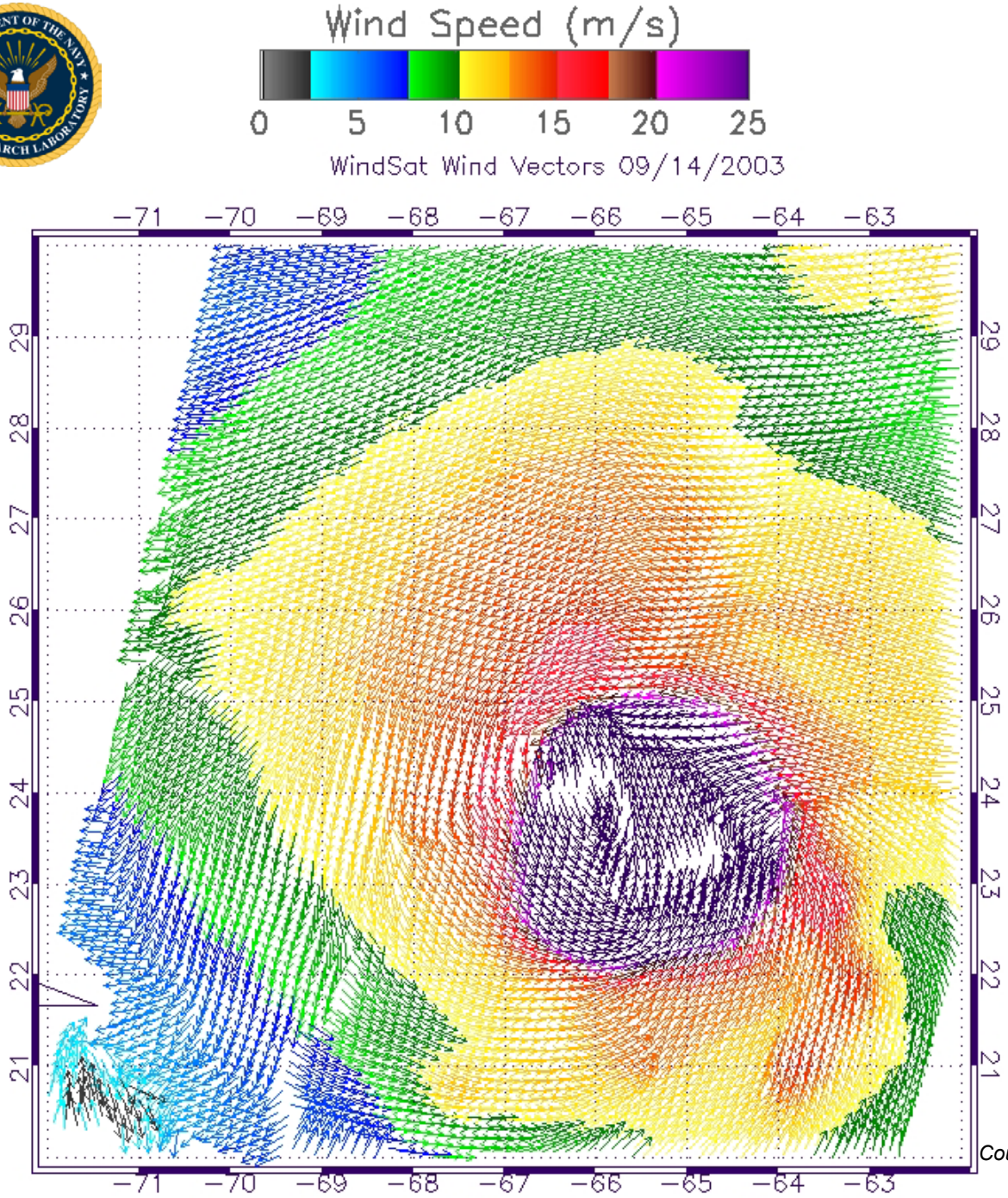
WindSat and QuikSCAT Wind Fields rev 04255

WindSat



QuikSCAT





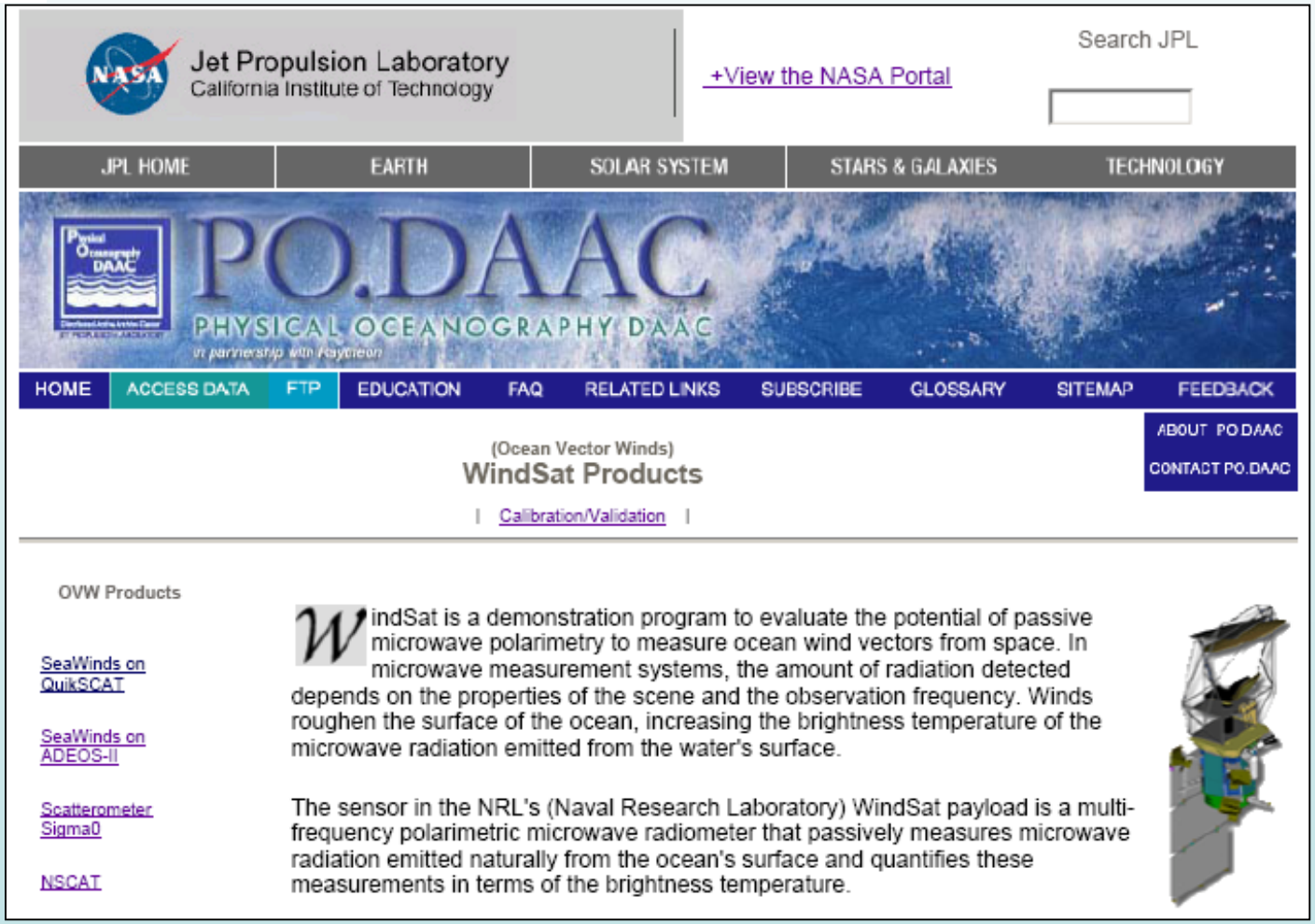
- **Full resolution image of Hurricane Isabel wind direction retrieved by the ORA MLE Algorithm**
- **Color coding represents retrieved Wind Speed**

Courtesy NOAA/NESDIS/ORA and NRL

Ongoing Work

- **Improving performance of wind vector retrievals**
  - Wind speeds below 7 m/s
  - Improving forward model performance across all conditions
    - Empirical and Physical Forward Models
    - Better incorporate the effects of foam
    - Atmospheric attenuation and reflected downwelling radiation
  - Improve rain flag and autonomous flagging of RFI
  - Incorporate lessons learned from feedback from ocean wind science community and other data users
- **Improve ambiguity removal techniques**
  - May be able to improve ambiguity selection by incorporating results from different retrieval algorithms, which have different ambiguity structures
  - Add physical realism criteria to selection process
- **Higher spatial resolution**
  - Train and test retrieval algorithms at higher spatial resolutions (smaller footprint but higher noise)
  - Demonstrate improvement with two-look retrieval technique

WindSat Data Portal

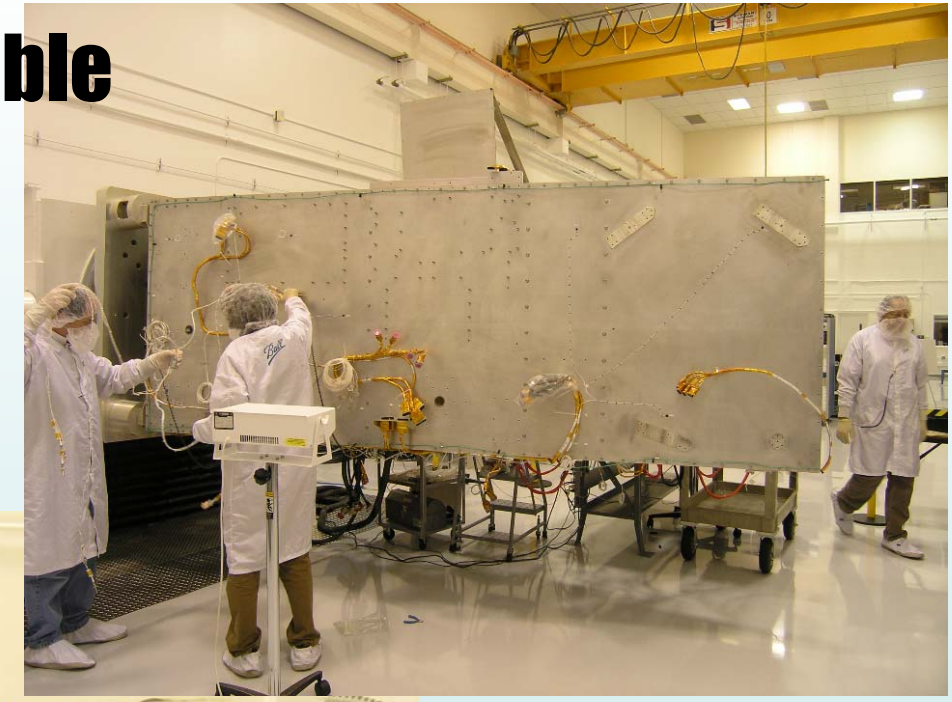


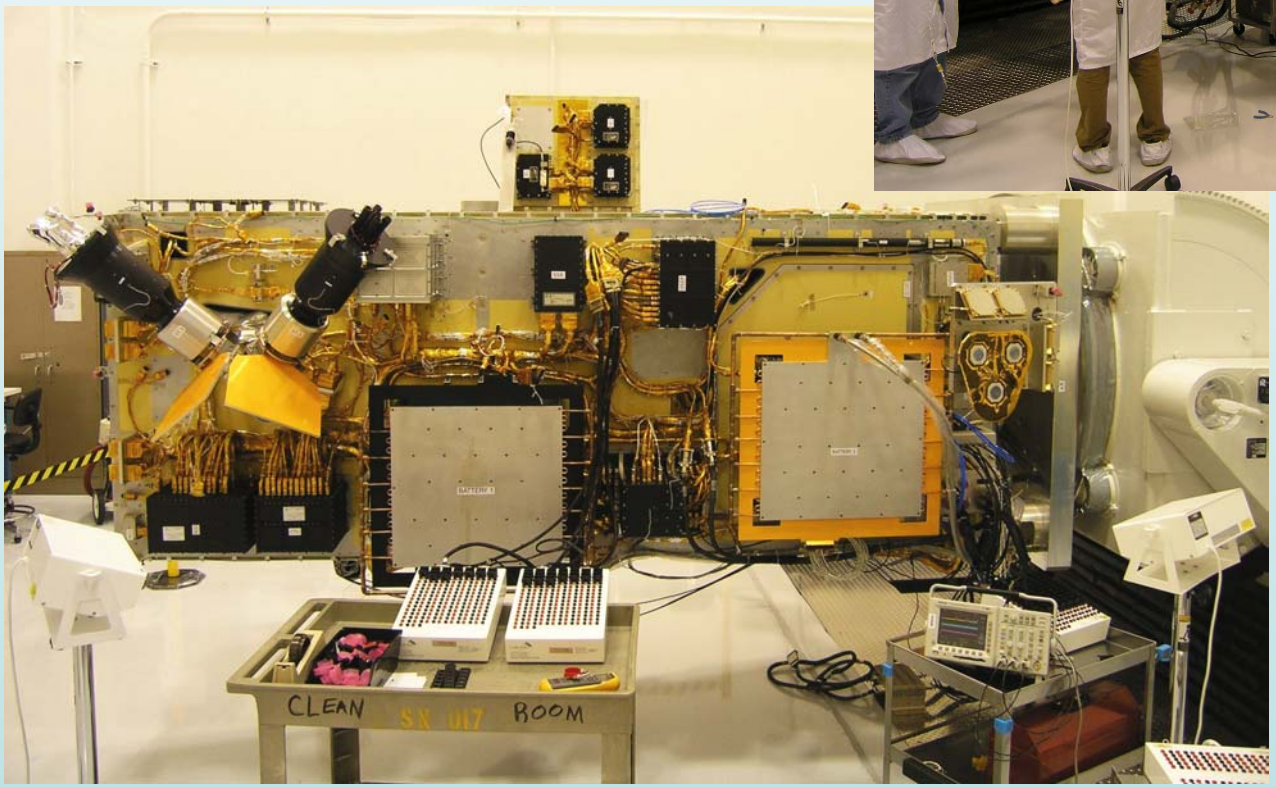
http://podaac.jpl.nasa.gov/windsat

NPOESS Preparatory Project (NPP)
Joint IPO-NASA Risk Reduction Demo

- NPP Spacecraft contract awarded to Ball Aerospace – May 2002
- Instrument Risk Reduction – 2006 Launch
  - Early delivery / instrument-level test / system-level integration and test
    - VIIRS - Vis/IR Imager Radiometer Suite (IPO)
    - CrIS - Cross-track IR Sounder (IPO)
    - ATMS - Advanced Technology Microwave Sounder (NASA)
    - OMPS – Ozone Mapping and Profile Suite (IPO)
  - Provides lessons learned and allows time for any required modifications before NPOESS first launch
- Ground System Risk Reduction
  - Early delivery and test of a subset of NPOESS-like ground system elements
  - Early User Evaluation of NPOESS data products
  - Provides algorithms / instrument verification and opportunities for instrument calibration / validation prior to first NPOESS launch
  - Allows for algorithm modification prior to first NPOESS launch
- Continuity of data for NASA's EOS Terra/Aqua/Aura missions

NPP: Space Available





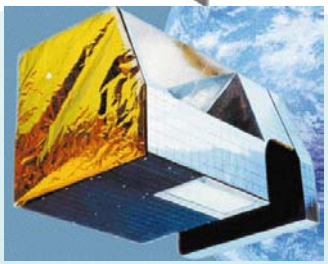
Instrument Status

Development Sensor Highlights

Visible/Infrared Imager Radiometer Suite (VIIRS)

Raytheon Santa Barbara Prototype in assembly/qual, flight unit in production

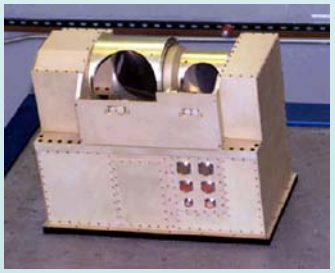
- 0.4 km imaging and 0.8 km radiometer resolution
- 22 spectral bands covering 0.4 to 12.5 μm
- Automatic dual VNIR and triple DNB gains
- Spectrally and radiometrically calibrated
- EDR-dependent swath widths of 1700, 2000, and 3000 km



Crosstrack InfraRed Sounder (CrIS)

ITT Ft Wayne Prototype in qualification, flight unit in production

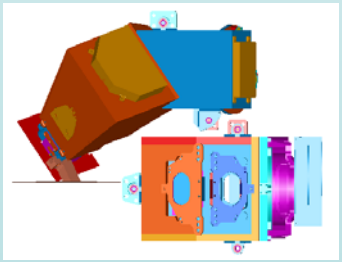
- 158 SWIR (3.92 to 4.64 μm) channels
- 432 MWIR (5.71 to 8.26 μm) channels
- 711 LWIR (9.14 to 15.38 μm) channels
- 3x3 detector array with 15 km ground center-to-center
- 2200 km swath width



Advanced Technology Microwave Sounder (ATMS) - NASA

Northrop Grumman Electronics Flight unit in qualification

- CrIS companion cross track scan
- Profiling at 23, 50 to 57, 183 GHz
- Surface measurements at 31.4, 88, 165 GHz
- 1.1, 3.3, and 5.2 deg (SDRs resampled)
- 2300 km swath width

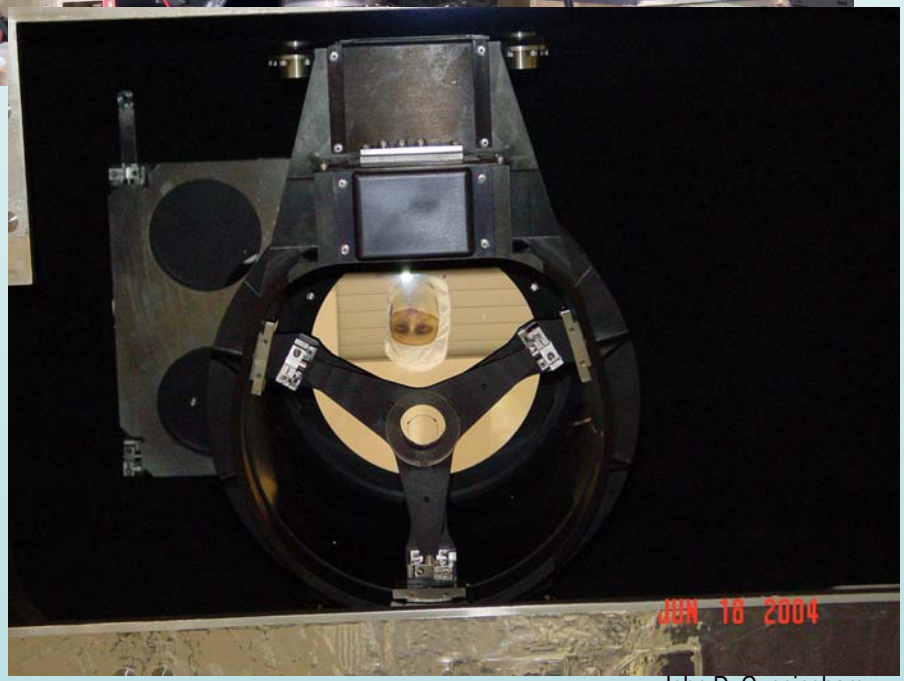


Ozone Mapping and Profiler Suite (OMPS)

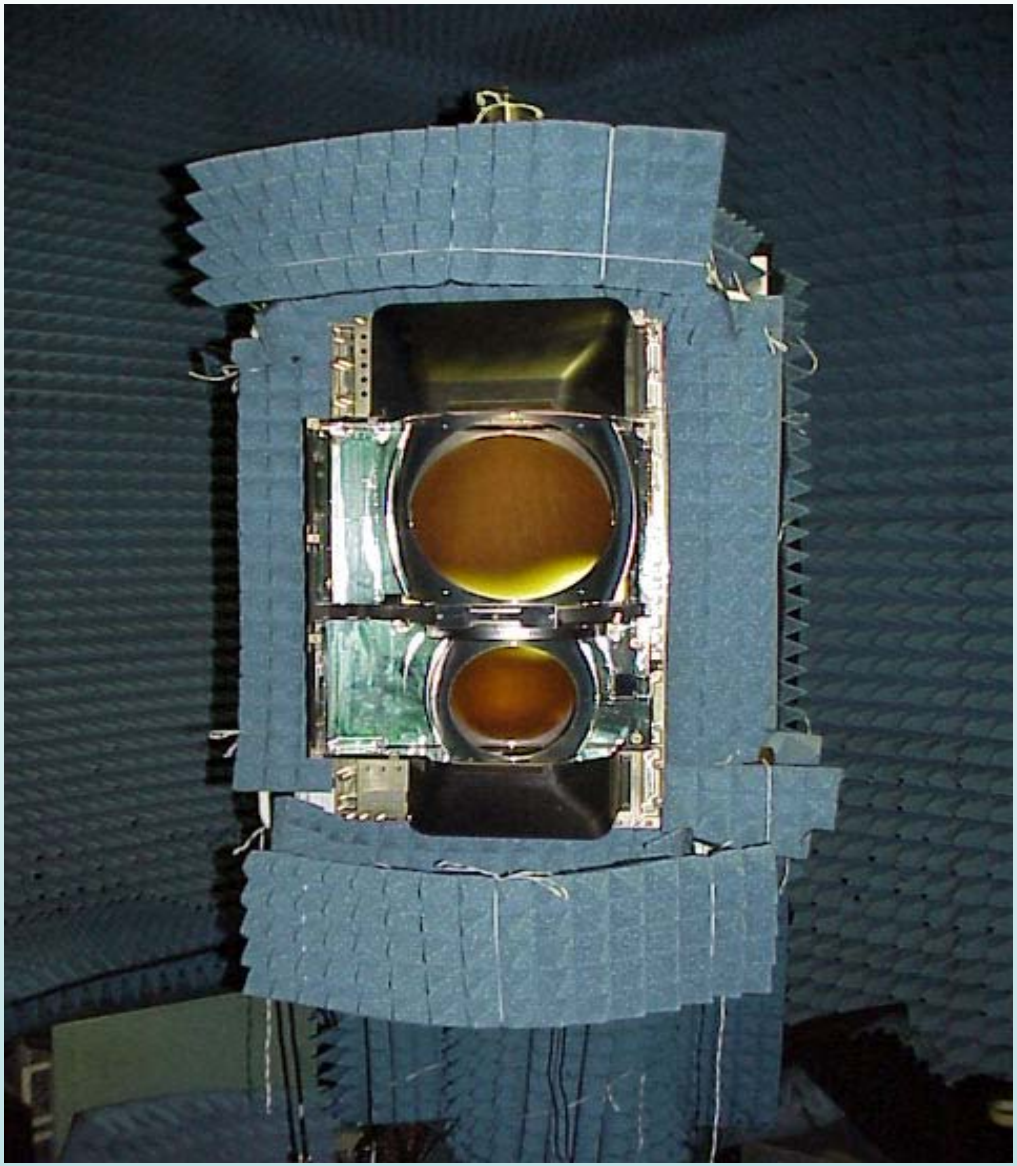
Ball Aerospace Flight unit in production

- Total ozone column 300 to 380 nm with 1.0 nm resolution
- Nadir ozone profile 250 to 310 nm with 1.0 nm resolution
- Limb ozone profile 290 to 1000 nm with 2.4 to 54 nm resolution
- Swath width of 2800 km for total column

VIIRS Engineering Unit Electronics Module and Optics Module



ATMS – First Flight Unit Antenna Subsystem



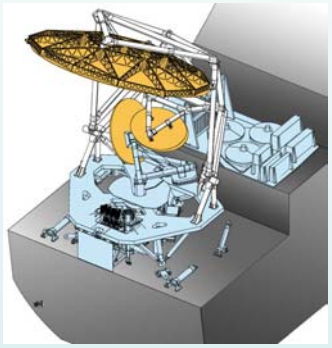
CrIS Flight Unit Telescope -- delivered and ready for sensor integration

Successfully completed vibration test

Integrated into sensor

In optical alignment

Development Sensor Highlights (cont.)

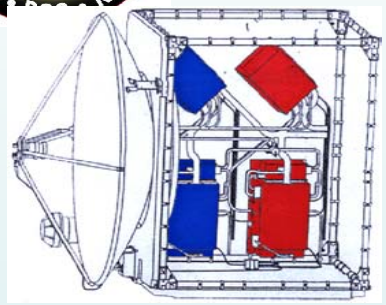


Conical Scanning Microwave Imager/Sounder (CMIS)

Boeing Space Systems Delta PDR complete

- 2.2 m antenna
- RF imaging at 6, 10, 18, 36, 90, and 166 GHz
- Profiling at 23, 50 to 60, 183 GHz
- Polarimetry at 10, 18, 36 GHz
- 1700 km swath width
- Radio Interference (RFI) ECP complete

Leverage Sensor Highlights



Radar Altimeter (ALT)

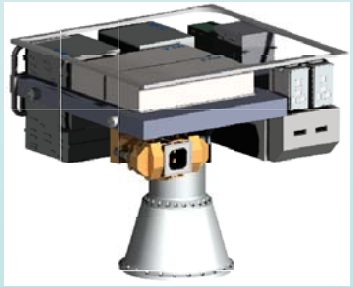
Alcatel

- Measures range to ocean surface with a radar at 13.5 GHz
- Corrects for ionosphere with 5.3 GHz radar
- Corrects for atmosphere with CMIS water vapor measurements
- Precise orbit determination with GPS

Earth's Radiation Budget Suite (ERBS)

Northrop Grumman Space Technology

- Three spectral channels
- Total radiation measurement 0.3 to 50 μm
- Shortwave Vis and IR measurement 0.3 to 5 μm
- Longwave IR measurement 8 to 12 μm



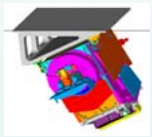
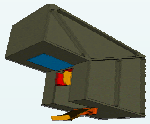
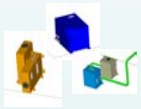
Total Solar Irradiance Sensor (TSIS)

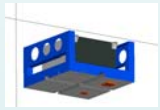
University of Colorado Design underway

- Two sensors for total irradiance (TIM) & spectral irradiance (SIM)
  - TIM measures total solar irradiance
  - SIM measures spectral irradiance 200 to 2000 nm
- Pointing platform and sensor suite to be provided by CU LASP

Survivability Sensor (SS)

Highlights of Other Sensors

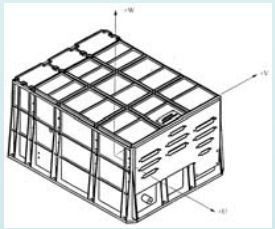
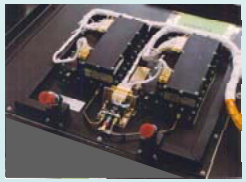




Space Environment Sensor Suite (SESS)

Ball Aerospace Final instrument suite being selected

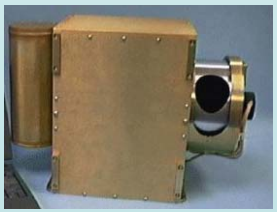
- Sensor suite collecting data on particles, fields, aurora, and ionosphere
- Suite includes a UV disk imager (BATC), charged particle detectors (Amptek/U. of Chicago), thermal plasma sensors (UTD)
- Will distribute suite on all 3 orbital planes

Advanced Data Collection System (ADCS) and Search and Rescue Satellite-Aided Tracking (SARSAT)

ITAR agreements done, integration meetings underway

- "GFE" to NPOESS from France and Canada
- ADCS supports global environmental applications
- SARSAT collects distress beacon signals



Aerosol Polarimetry Sensor (APS)

Raytheon Santa Barbara Research Center Full development on hold pending NASA satellite "Glory" plans

- Aerosol characterizations of size, single scattering albedo, aerosol refractive index, aerosol phase function
- Multispectral (broad, 0.4 to 2.25 μm)
- Multiangular (175 angles)
- Polarization (all states)

P3I

Pre-Planned Product Improvement

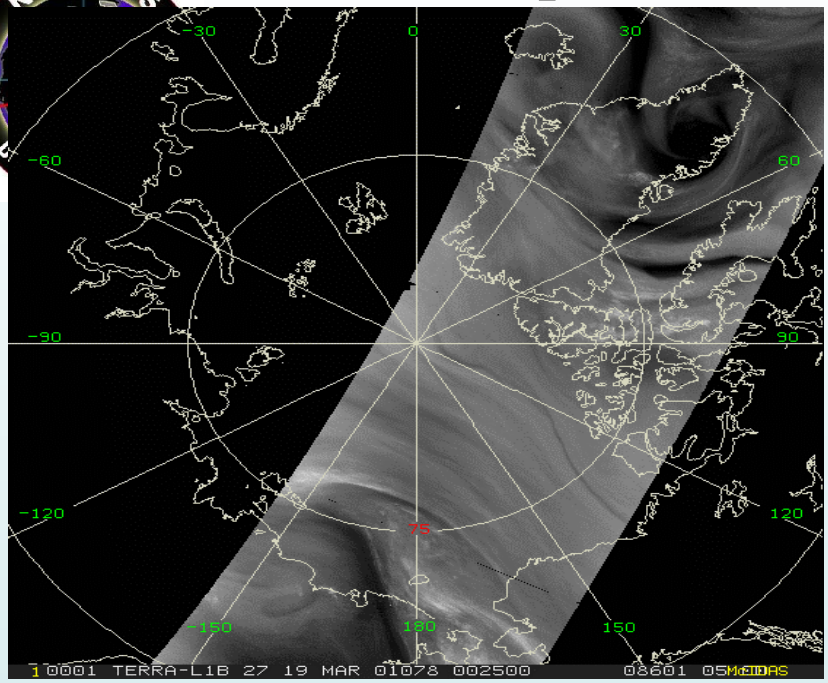
NPOESS P3I

- **Need for continued evolution recognized from the very beginning of NPOESS program**
  - P3I requirements in paras 1.6 and 4.1.6.8 of IORD II
  - NASA's role in NPOESS (per PDD) is technology development

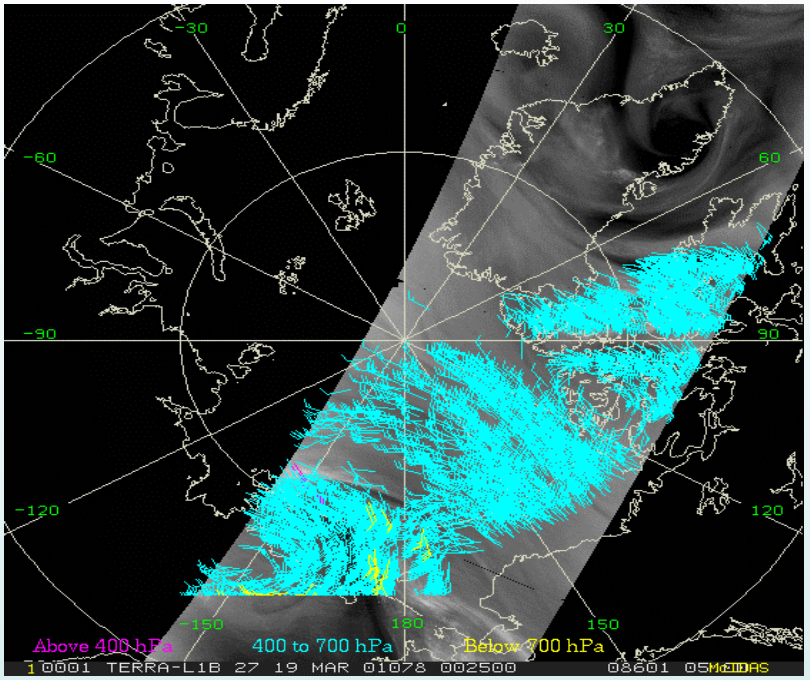
- **P3I is built into the NPOESS program to :**
  - Respond to changing/modified user needs
  - To track, monitor, and respond to identified user products that the current NPOESS system can not implement due to technological constraints.

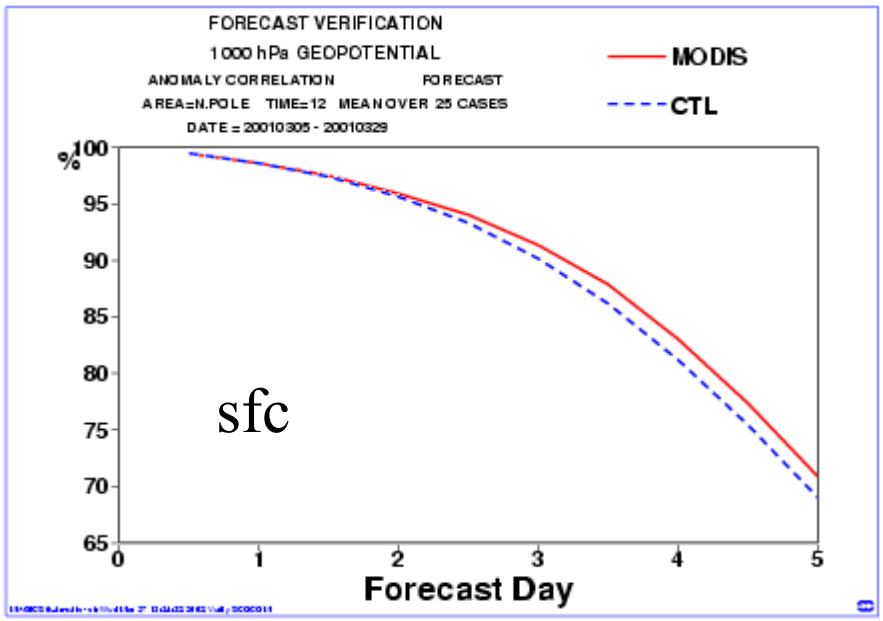
- **Two forms of NPOESS P3I are envisioned**
  - Modification of existing sensor to accomplish need
  - New sensor development required to implement need

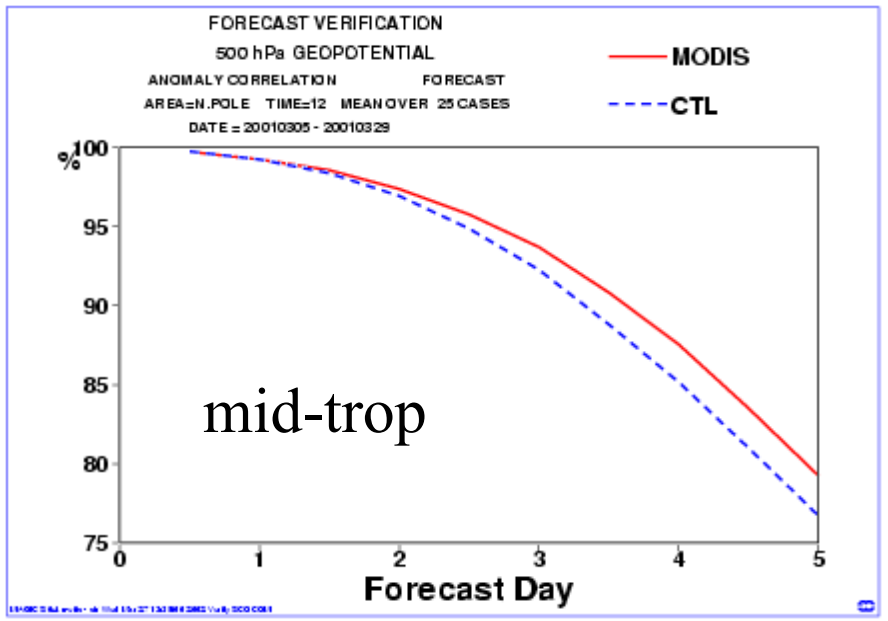
Polar WV Loops

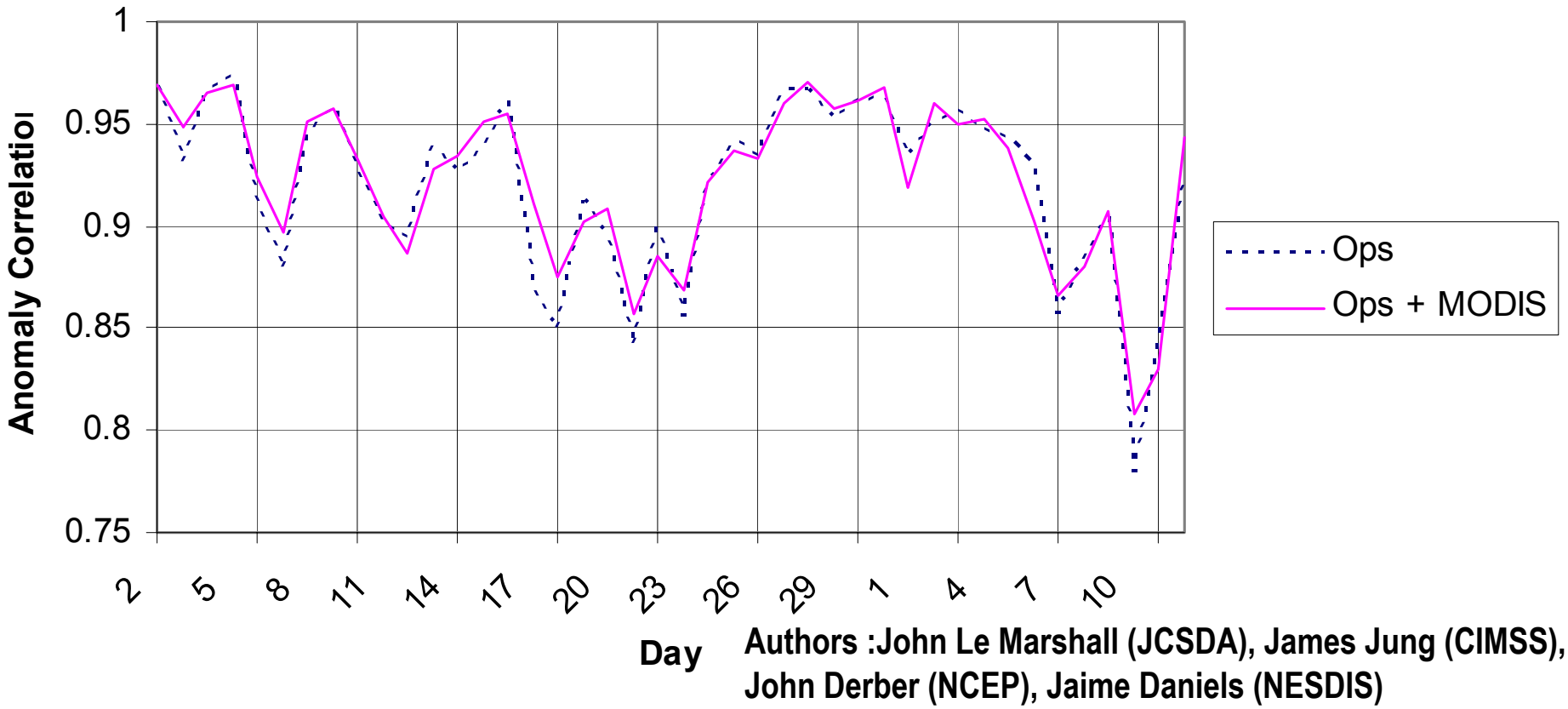


Winds improve Wx Fcst

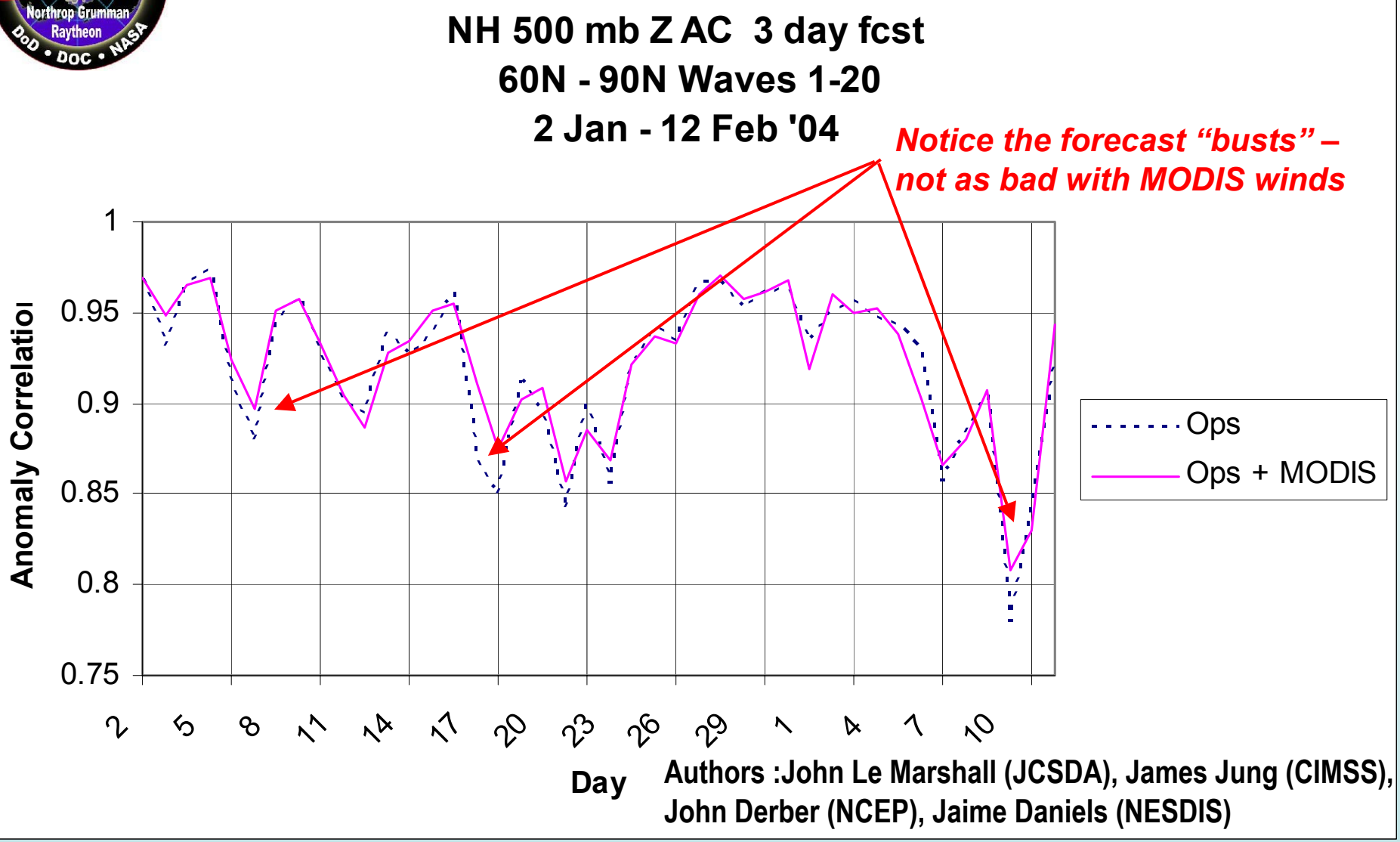








Note significant improvement in poor NH forecasts



Note significant improvement in poor NH forecasts

So how do we do this. . . . ?

- **VIIRS does have a requirement to measure water vapor**
- **VIIRS *DOES NOT* have a requirement to image water vapor**
- **So how do we do this…**
  - **Modify VIIRS by adding a 6.7μ channel**
  - **Requires redesign of sensor in midwave to long wave band split**
  - **Treat as a block change in our production satellites**
- First steps already taken by purchasing “lenslets” before vendor went out of business
- Change will take additional funds

CrIS Full Resolution Capability

- **CrIS data fidelity was reduced to constrain data bandwidth prior to system source selection**
  - Full resolution is measured by the instrument
  - What we had

Band	Data provided	Resolution (cm^{-1})
– Short	Fourth	2. 5
– Mid	Half	1.25
– Long	Full	.625

- **What we're doing**
  - Examining capability to bring down full data
  - Not a data rate problem due to 1394a data bus
  - Studying best way to modify sensor
  - Running simulations to show performance as part of the value trade
- **Plan**
  - Complete study this winter, determine cost/benefit trades
  - Present to SUAG
- **Why?**
  - **Carbon trace gasses!**

What about new capabilities?

- **IPO recognized user need for detailed interface information is essential for successful proposal**
- **Commissioned NGST to develop "payload manual"**
  - Provides detailed requirements and information
  - Defines several levels of P/L (based on complexity)
- **Status**
  - Midterm review held in June
  - Final report/manual out this month

How We're Going to Do This …

- **Announcement of opportunity**
  - Define dates, selection rules
  - Establish priorities for NPOESS P3I needs
- **Use NASA New Millennium and DoD Space Experiment Review Board (SERB) process for US candidates**
  - Also ensures parent agency support
- **IPO board review proposals, select candidates**

Interested??…
Talk to Mr Stan Schneider, our Associate Director for Tech Transition

Landsat Data Continuity Mission on NPOESS

White House Direction on Landsat

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20502

August 13, 2004

MEMORANDUM FOR THE SECRETARY OF STATE
THE SECRETARY OF DEFENSE
THE SECRETARY OF THE INTERIOR
THE SECRETARY OF AGRICULTURE
THE SECRETARY OF COMMERCE
THE SECRETARY OF HEALTH AND HUMAN SERVICES
THE SECRETARY OF TRANSPORTATION
THE SECRETARY OF HOMELAND SECURITY
ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY
DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET
DIRECTOR OF CENTRAL INTELLIGENCE
ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
DIRECTOR, NATIONAL SCIENCE FOUNDATION
ASSISTANT TO THE PRESIDENT FOR NATIONAL SECURITY AFFAIRS

From: John H. Marburger, III, Director

Subject: Landsat Data Continuity Strategy

This memorandum is to inform you of the outcome of interagency discussions to ensure the continuity of Landsat-type data observations. For over 30 years, the Landsat series of satellites has gathered multi-spectral images of the Earth's land surface and surrounding coastal regions. Landsat is a national asset, and its data have made -- and continue to make -- important contributions to U.S. economic, environmental, and national security interests. Specifically, Landsat images are the principal source of global, medium resolution, spectral data used by Federal, state, and local government agencies, academia, and the private sector in land use/land cover change research, economic forecasting, disaster recovery and relief, and the scientific study of human impacts on the global environment. Additionally, Landsat data are utilized by over 70 countries and are an important part of a global, integrated Earth observation system.

The future availability of imagery from the existing Landsat satellite constellation remains uncertain. Although Landsats 5 and 7 are currently on orbit, Landsat 5 was launched in 1984 and has far exceeded its expected lifetime, and Landsat 7 has developed a technical problem that limits the utility of the data it produces. In addition, the lack of viable commercial markets for Landsat data led to the cancellation of plans to pursue Landsat data continuity as a public-private

partnership. Any disruption in the continuous availability of Landsat imagery, products and value-added services will adversely affect governmental, international, and other users and may limit use of the global data set for certain types of scientific analysis.

In order to maintain Landsat's legacy of continual, comprehensive coverage of the Earth's surface, the United States Government will transition the Landsat program from a series of independently planned missions to a sustained operational program and establish a long-term plan for the continuity of Landsat data observations. In particular, the Departments of Defense, the Interior, and Commerce and the National Aeronautics and Space Administration have agreed to take the following actions:

- Transition Landsat measurements to an operational environment through incorporation of Landsat-type sensors on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) platform, thus ensuring long-term continuity of these high-priority measurements and providing for integrated collection and availability of data from these two critical remote sensing systems;

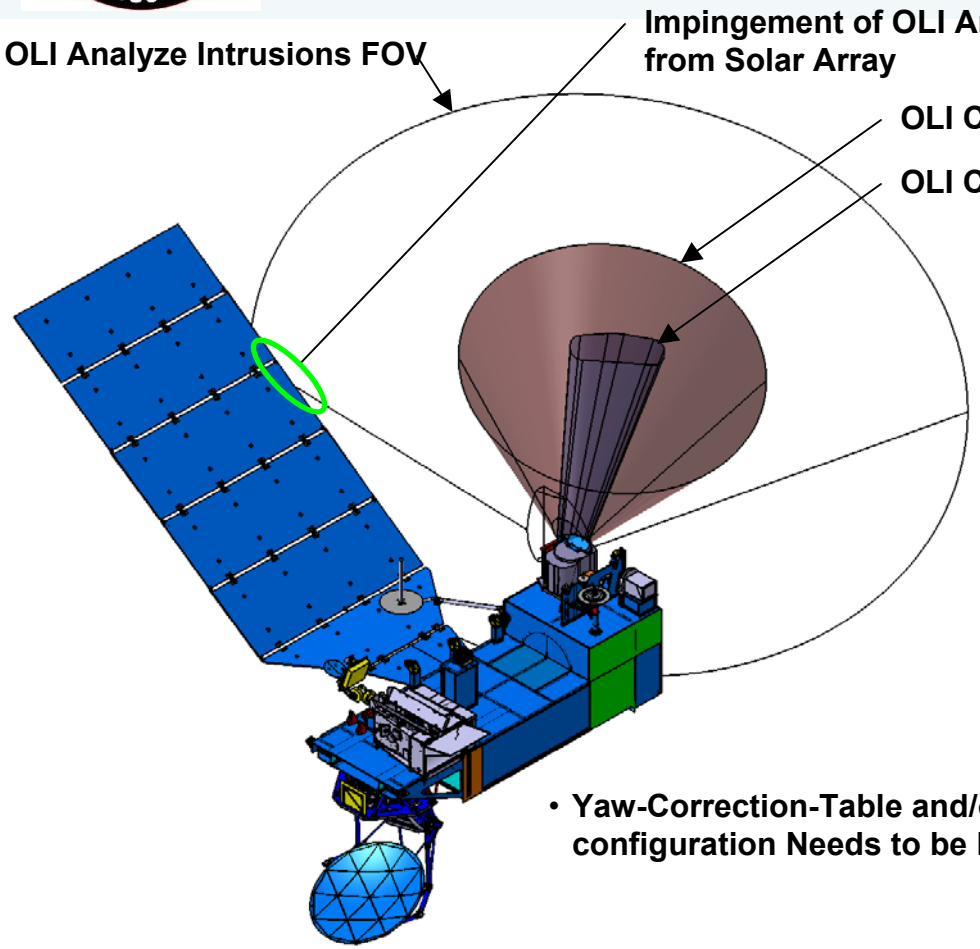
- Plan to incorporate a Landsat imager on the first NPOESS spacecraft (known as C-1), currently scheduled for launch in late 2009. The specific implementation plan shall be jointly reviewed and approved by the NPOESS Executive Committee and Landsat Program Management; and

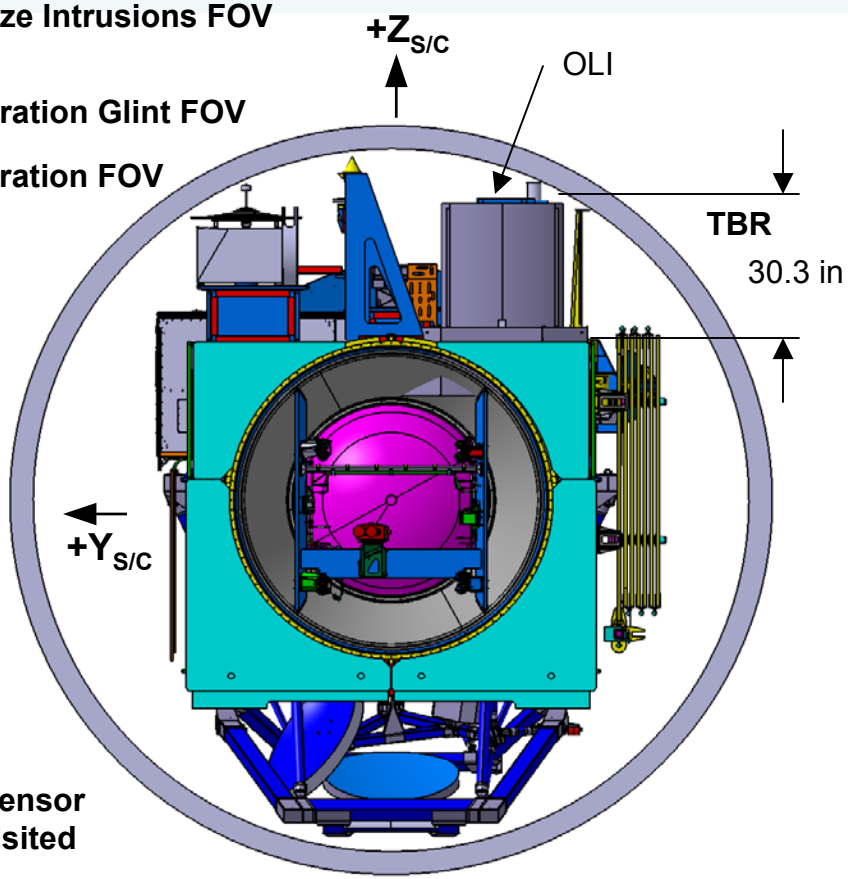
- Further assess options to mitigate the risks to data continuity prior to the first NPOESS-Landsat mission, including a "bridge" mission.

This NPOESS-Landsat operational strategy will need to be justified through the normal budget process. Implementation will be subject to the availability of appropriations, other applicable laws, and Presidential guidance. The cost sharing requirements of the baseline NPOESS program do not apply to the integration of Landsat into NPOESS.

These actions will ensure long-term continuity of these high-priority land, oceanic, and atmospheric measurements and will provide integrated collection and availability of data from these critical remote sensing systems for national and global applications.

OLI Accommodation on NPOESS





- Yaw-Correction-Table and/or Sensor configuration Needs to be Revisited

Ø4m L/V Fairing Shown

- Adequate Clearance Margin for OLI Calibration FOV
- Adequate Clearance Margin for OLI Calibration Glint FOV
- Adequate Clearance Margin between Notional OLI Hardware and L/V Fairing

NPOESS C1 (2130 orbit) Provides Ample Mass and Power Margin for OLI

Mass

NPOESS C1	Mass (kg)
Payload	**737**
VIIRS	247
CMIS	329
SARSAT	34
APS	34
SS	17
P/L Contingency	76
Spacecraft	**3447**
Structure	1061
Thermal	124
Propulsion	58
EPS	618
ACS	122
C&DH	114
RF Comm	53
Cable/Harness	246
S/C Contingency	271
Booster Adapter	180
Propellant	600
Satellite (Wet)	**4184**
Sat Max Weight	**5533**
Available Margin	**1349**

Margins to host additional missions designed into NPOESS from beginning

Mass/power budgets from include P/L and S/C contingency

Mass margin = 32%
Power margin = 34%

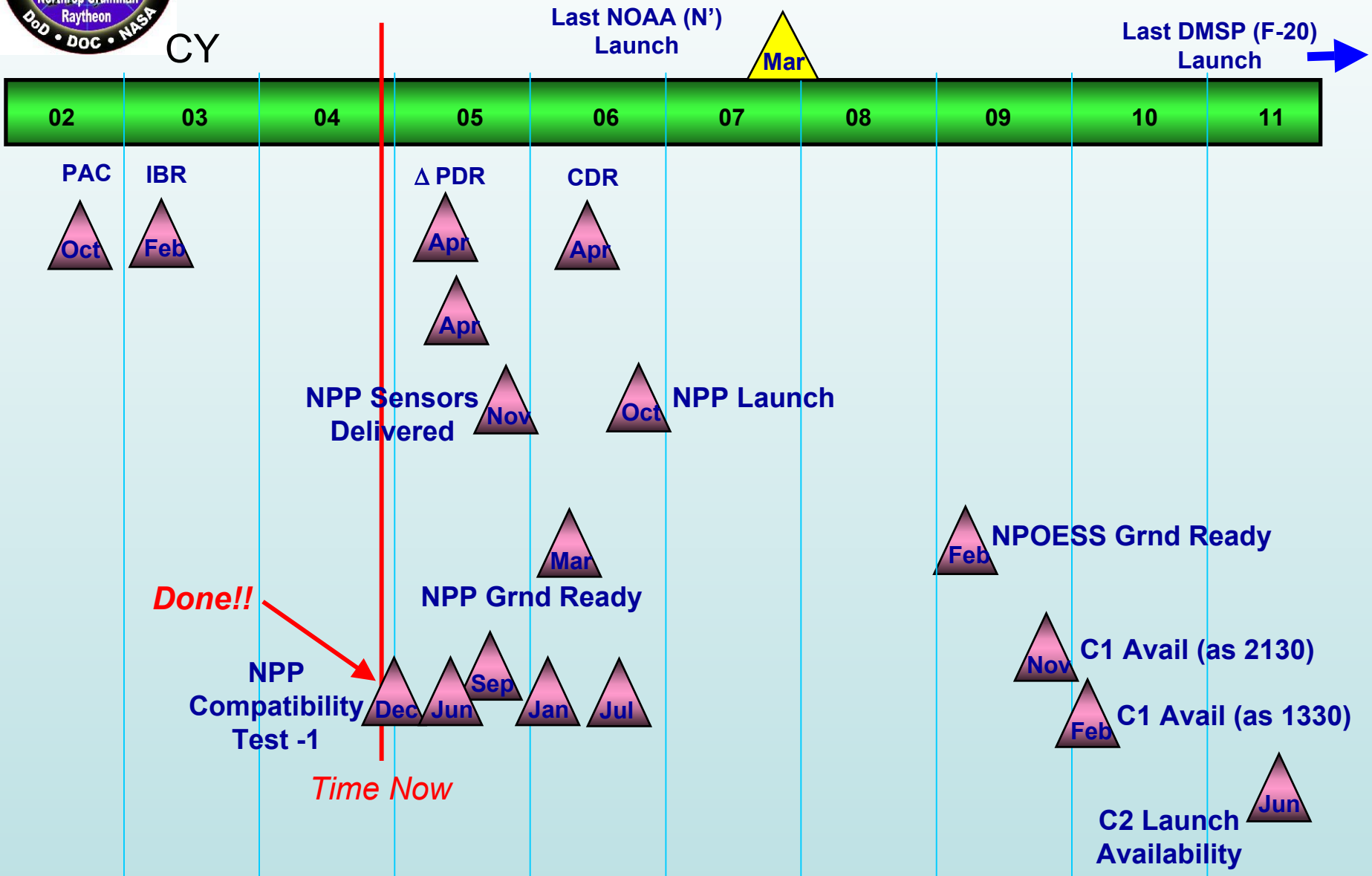
Power

NPOESS C1	Power (W)
Payload	**733**
VIIRS	188
CMIS	359
SARSAT	69
APS	36
SS	46
P/L Contingency	35
Spacecraft	**4063**
Structure	0
Thermal	116
Propulsion	39
EPS	603
ACS	225
C&DH	420
RF Comm	408
Cable/Harness	0
S/C Contingency	193
Battery Charge	1911
Harness Loss	148
Satellite	**4796**
Sat Max Power	**6411**
Available Margin	**1615**

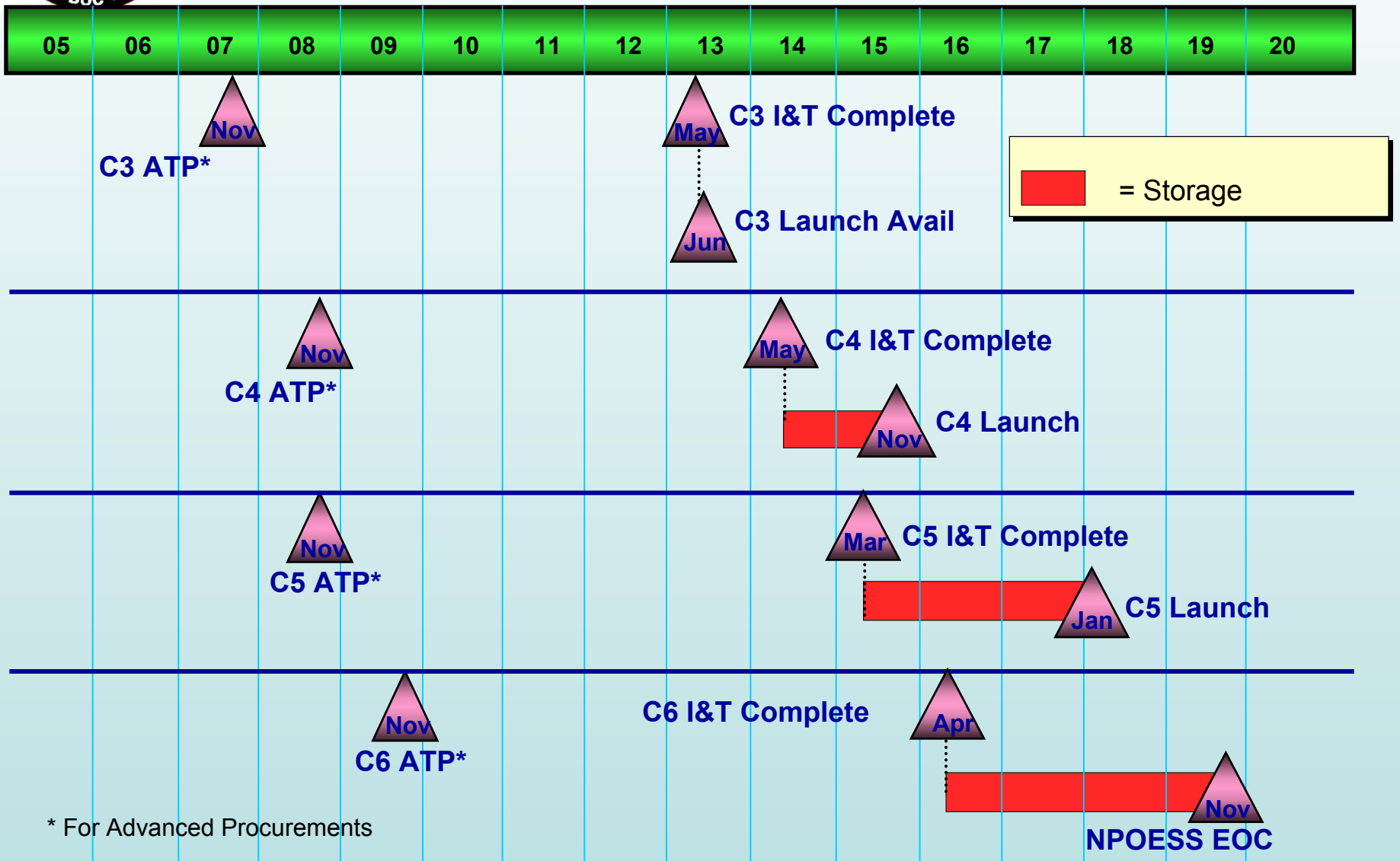
NPOESS C1 literally has greater than one "ton" of mass margin and over 1 kW of power margin available to support OLI

Our Schedule

NPOESS Program Schedule



NPOESS Program Schedule – Production Replan



* For Advanced Procurements

Improved Sensor Technology Provides New Weather Insights

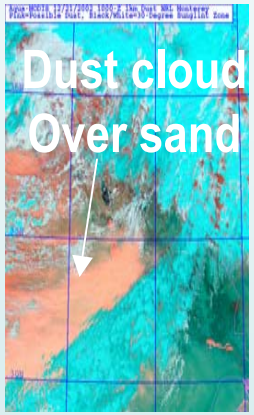
Increased spectral availability allows discrimination of tough weather problems

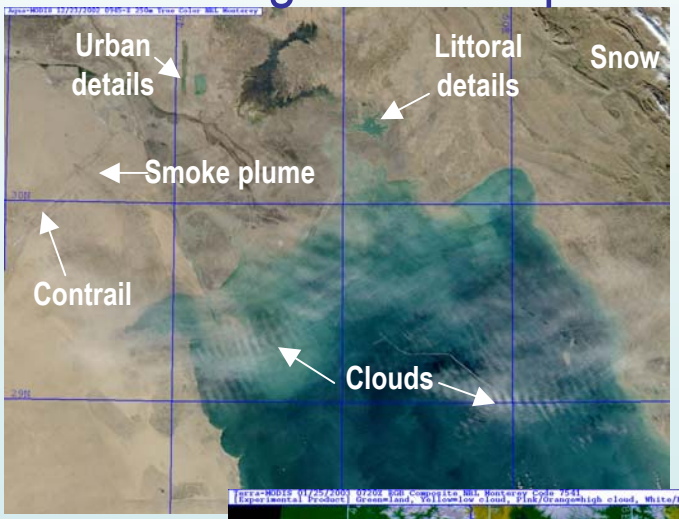
DMSP/POES
OLS / AVHRR
1 vis band
1 to 5 IR bands

Gray shades

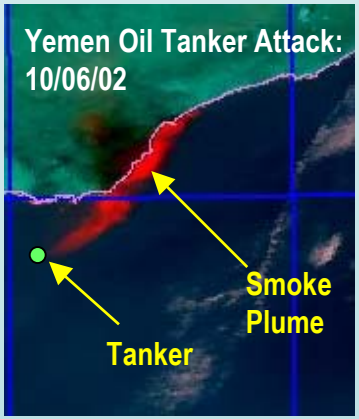
NPOESS
VIIRS
[MODIS Simulation]
9+ VIS/NIR bands
12 IR bands

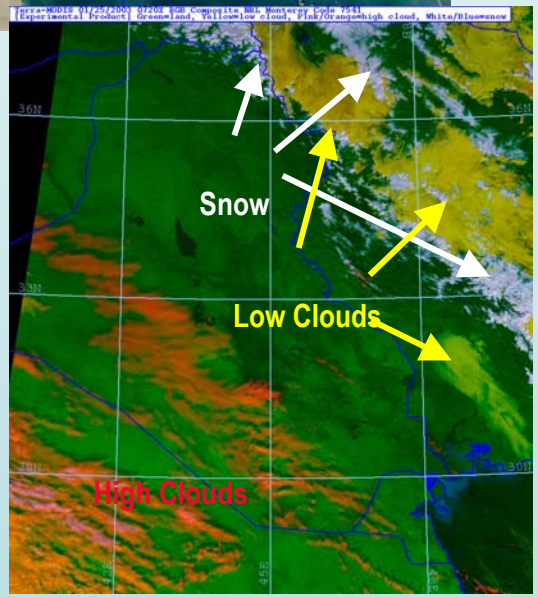
True color



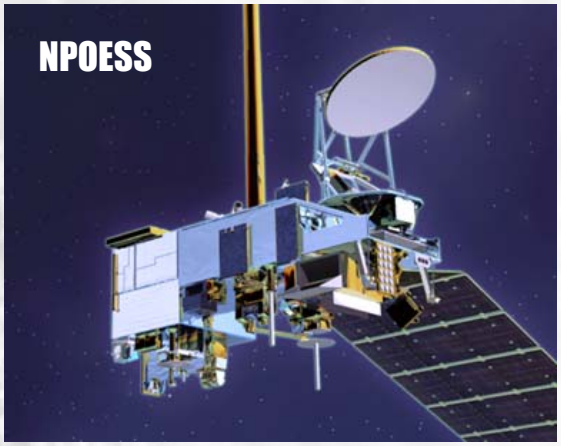


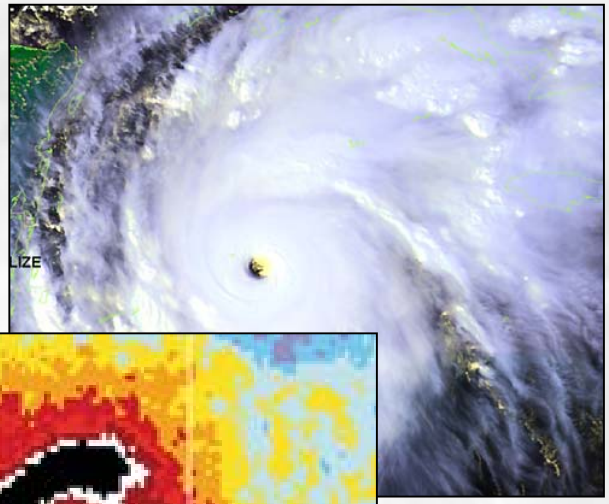
Tough Problems Solved



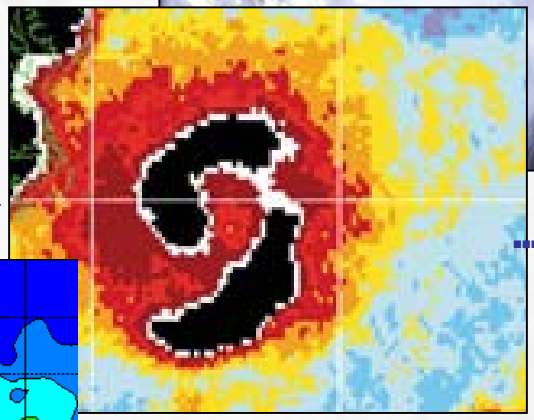


Coincident Advanced Sensors Provide Synergy

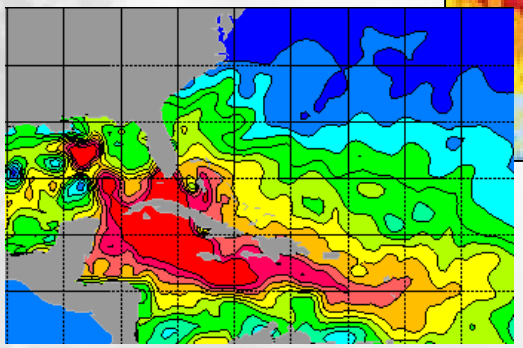




Multispectral Imagery From VIRRS...



...combined with ATMS/CMIS Microwave EDRs...



...and Altimeter-Derived Ocean Heat Content...

Reduced Impact on Maritime Resources

Advanced Sensors Critical for Ocean Predictions

Altimeter

VIRRS

Sea Surface Height (SSH)

Sea Surface Temperature

Modular Ocean Data Assimilation System (MODAS)

Operational Global Ocean Modeling

Regional Scale Modeling & Assimilation

Wave & Surf Modeling /Assimilation

NPOESS EDRs--SSH and SST--will be Critical, fundamental components of the ocean analysis and prediction capability

Bathymetry & Gravity

Applications

Tide Modeling

Active & Passive Acoustic Propagation Predictions

Summary

- **Program is making solid progress**
  - Instruments will all be in test by the end of the year
    - Preliminary tests show excellent performance!!
  - NPP spacecraft proceeding on schedule
    - Completed C3 tests with NPOESS ground system
    - Completed 1394a data bus -- shows new instruments will "talk" to satellite
- **There ARE technical challenges**
  - VIIRS has faced and overcome significant technical problems
  - OMPS detectors are pacing assembly and test
  - CrIS and ATMS are doing fine in test

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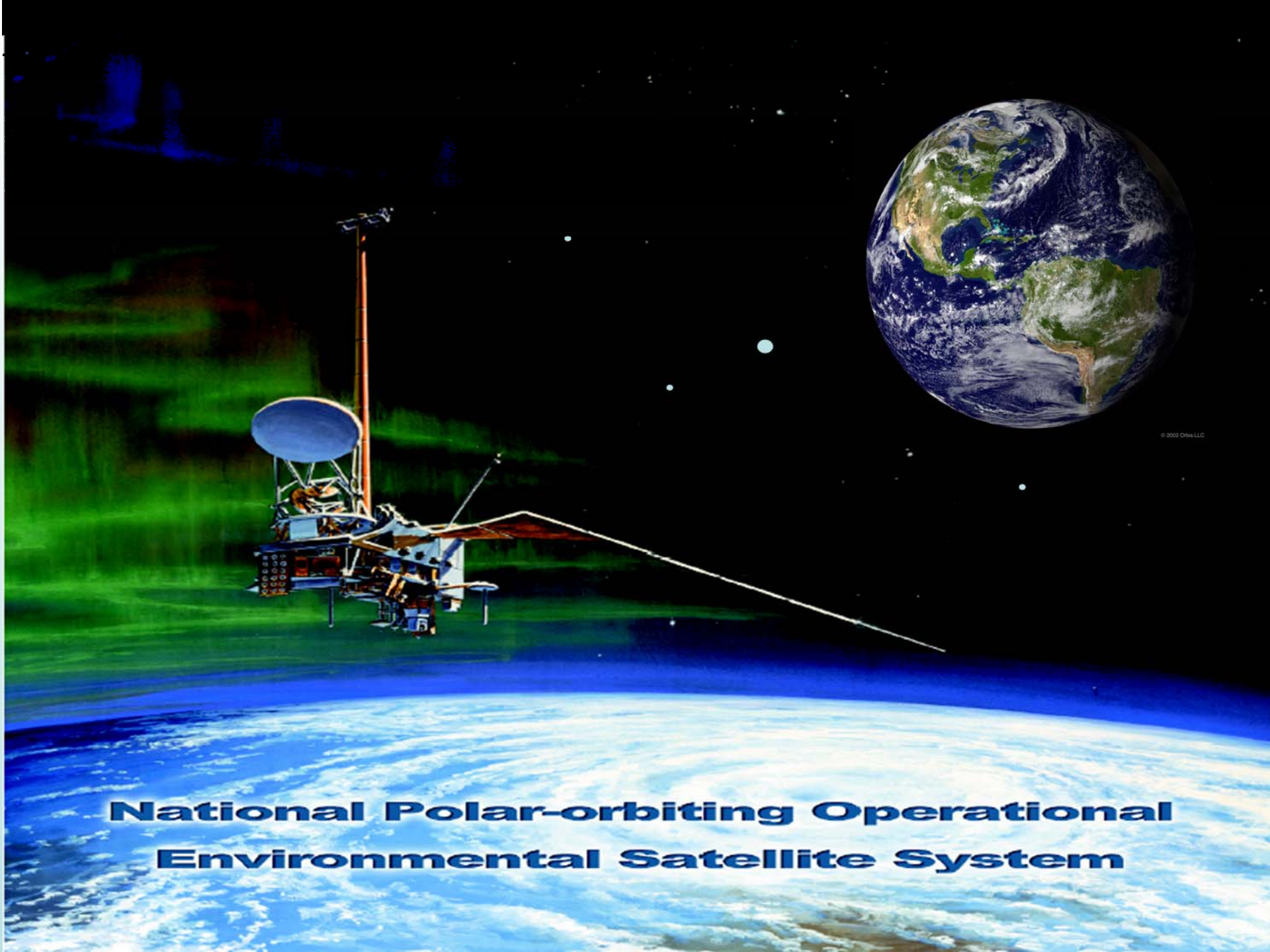
National Polar-orbiting Operational
Environmental Satellite System